Financial Constraints, Inventory Investment, and the Volatility of Production

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CERTIFICATE

It is certified that the work contained in the thesis entitled *Financial Constraints, Inventory Investment, and the Volatility of Production* by **Anita Singh** has been carried out under my supervision and that this work has not been submitted elsewhere for a degree

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SYNOPSIS

It is well known that the inventory decisions of firms make production more volatile than sales at the firm, industry and macro levels The production smoothing models, though they still form the basis for much of the empirical work, cannot sustain this stylized fact The most prominent alternative explanations of this fact are the persistence of (a) demand shocks (Blinder (1982)), and (b) cost shocks (Miron and Zeldes (1988)) In these models both production and sales are assumed to be flexible ex ante whereas only sales is variable ex post These are neoclassical versions, akin to the production smoothing model, based on the assumption of perfect capital markets and provide sufficient conditions Unanticipated changes (shocks) have a central determining role in these versions

Capital market imperfections are highlighted in the more recent literature See, for instance, the recent survey by Hubbard (1998) In this approach the persistence of credit constraints (whether they are anticipated or not) compels the firms to adjust production and sales It has been demonstrated, by extending the neoclassical Blinder model, that this offers another sufficient condition to explain the stylized fact at least under certain assumptions

The basic contention of this study is that when the product markets are oligopolistic or monopolistic competition the firms rarely have any ex post flexibility with respect to

sales (that is, they cannot reverse the ex ante choice just because the credit conditions have changed) In contrast, the existence of excess capacity makes production more flexible ex post The brunt of the adjustment to credit constraints therefore falls on the volume of production Though this is also a sufficient condition for the observed stylized fact it emphasizes the proposition that the variance of sales is independent of the level of credit available to the firms

All the three alternatives were synthesized by utilizing the Blinder model This was achieved basically by appending the balance sheet constraint to the original modeling framework The resulting theoretical model contains the above hypothesis as one of the possibilities

An empirical test of the hypothesis was developed for 15 industry groups The database was a time series from 1964-65 to 1994-95 obtained from the Reserve Bank of India Since the Blinder model considers output and sales as joint decisions of the firm these two equations were estimated by utilizing Zellner's SURE after checking for unit roots with the help of the Dickey Fuller test There was an overwhelming evidence for the credit constraint hypothesis The cost shocks (including various components like raw materials, power and fuel, and wages and salaries), and the demand shocks had an important affect on both production and sales decisions Both these explanations complement the effect of the credit constraint The production decisions of six industry groups have not been influenced by financial constraints In these cases the demand shocks and cost shocks are the primary factors contributing to the greater volatility of

production Paper and Paperboard was the only industry for which the financial constraints affect the output decisions and yet production is less volatile than sales The greater variability of sales in this case is primarily due to (a) cost reductions achieved due to technological advancement and the consequent increase in demand in a fairly competitive environment, and (b) the increase in demand made possible by changes in consumer habits for a variety of paper based products Output changes over time could not be synchronized partly because of the agro-based raw material usage and the financial constraints

The basic implication of the study is that the credit policies of the central bank have been procyclical and aggravate the market determined business cycle effects A more stable rule based policy will have the advantage of stabilizing the business cycle Similarly, the management can stabilize its earnings profile if it can anticipate the credit constraints more accurately

As in the case of all other areas of economic research, studies on inventories in general, and this study in particular, are subject to several limitations Prominent among them are the following (a) Limitations of data – The sales equations can be improved if the data on selling costs is available Firm level data is generally possible However, it is too voluminous for one research worker to analyze it (b) Conceptual issues – Any comparison of variances is meaningful only if the appropriate time scale over which they are calculated is well defined Economic theory per se has been an insufficient guide

(c) Econometric techniques- In general, they have been able to justify more than one version of economic theory and any final resolution appears to be a remote possibility

On the whole a complete and final resolution of the greater volatility of production hypothesis has not been achieved and it is unlikely both in theory and econometric practice Even so there is by now a fairly deep understanding of the economic forces at work

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CHAPTER 1

Introduction

> Thinking about the opposite throws "open a skylight to a universe more mysterious and mischievous than we dare to imagine (It) tune(s) our ears to the sound of cosmic laughter "
>
> -Fraser (1998, p 149) with a little poetic license

1 1 Manufacturing Inventories

There is a widespread acknowledgement that inventories (final goods- with the manufacturers and retailers, raw materials, and goods in process) constitute a significant portion of sales at every level macro, industry, or the firm See, for example, Feldstein and Auerbach (1976), Blinder (1982), and Blinder and Maccini (1991a, b) In general, most of the product markets can be characterized as monopolistic competition or oligopoly Rival firms in such markets can be expected to compete with one another to capture emerging market opportunities As such a firm finds that there are goodwill costs of being out of stock if the demand cannot be met as it arises Every firm maintains some level of inventory It is also well known that just-in-time inventories do not eliminate the need for significant investments at some stage or another due to the time lags in production and delivery A significant inventory holding is ubiquitous

In general, the flexibility with which the production process can accommodate the exogenously given demand fluctuations determine the inventory behavior of the corporate sector For, in the absence of a suitable inventory policy firms will be compelled to make significant output adjustments whenever there are expected or unanticipated (shocks) changes in the demand for the product of the firm or their cost conditions As a result, inventories can have a stabilizing influence on the production decisions of firms Hence, a study of inventories is significant from the viewpoint of business policy in so far as it provides guidelines to the firms to achieve a relatively stable performance

In the more recent literature there is an acknowledgement that minor but random and unanticipated changes in the product markets can have a significant effect on the business cycle [1] It has been convincingly demonstrated that inventory investment, though a small component of the gross domestic product, has an overwhelming influence on the business cycle [2]

Further, the inventory policies of the firms are subject to policy constraints imposed on them In particular, the monetary authorities have been actively defining and monitoring

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[1] See, for instance, Blinder (1981) and Christiano et al (1996) Similarly, Fair(1989) found that demand shocks are the primary source of GNP fluctuations and West (1990) documented the interactive effects of demand and cost shocks on aggregate inventories in the U S

[2] Unlike the stabilizing influence at the firm level the macroeconomic effects tend to be destabilizing Part of the reason may be expectations regarding the demand conditions This will be considered again in the sequel

credit policies as they apply to this component of investment[3] Consequently business policies with respect to inventory investment have been influenced by such policies irrespective of whether they are anticipated or random In turn, such changes had an effect on macroeconomic stabilization as well In general, understanding the nature of various factors that determine inventory investment decisions has become important from the viewpoint of business policy as well as macroeconomic policy

1 2 Early Literature

The early theory of inventory investment assumed the following about the product markets, costs of production, and the cost of financing inventory

(a) Product markets are generally either monopolistic competition or oligopoly Firms faced random demand curves (mostly due to the reactions of the rival firms) They had to cater to market demand as it arises For, otherwise the continuity of demand for their product cannot be assured For all practical purposes the market demand for any firm is purely exogenous and firms do not have much flexibility in influencing it[4]

(b) Monopolistic and oligopolistic firms generally tend to operate at less than the capacity

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[3] The extent to which such policies are utilized varies from one country to another The quantitative credit controls as well as the variations in the interest rate policies have been quite significant in the Indian context

[4] Even studies dealing with advertising and product line choices maintain that the consumer determines the market demand and the firms must cater to it

level of output[5] However, if the fluctuations in the market demand are large enough they will have significant costs of adjusting production to market demand For, in general, they experience increasing marginal costs Though this is a fairly general assumption it is often postulated that production is not flexible ex post, i e , it cannot be fully adjusted to demand

(c) The financial markets are competitive As such the costs of financing inventory investment, as reflected in the market rate of interest, is the only determining financial constraint In much of the empirical work, the interest costs were found to be insignificant mostly because the firm can recover such costs in monopolistic markets by an appropriate pricing policy[6]

Two prominent theories about inventory investment were developed against this background One is the famous inventory cycle model studied essentially by Lovell (1961, 1993) and others According to this theory, given the production capacity of the

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[5] The definition of the capacity level of output may be controversial In the present context it is taken to be the minimum point on the average cost curve

[6] Whenever this is true an increase in interest costs may increase prices, inventory levels and so on Various aspects of this problem have been examined by Chevalier and Scharfstein (1995, 1996), Rotemberg and Saloner (1986), and Rotemberg and Woodford (1991, 1992) In many practical situations the firm adopts a retail price maintenance policy Hence, this approach is not attractive The neoclassical assumption that financial markets are competitive suggests that an increase in the interest rate reduces inventory investment via the cost effect Kuznets (1964, p 335 and p 336) documented the existence of such an interest rate effect Other studies, such as Akhtar (1983) and Callen et al (1990), also found confirming evidence In particular, Akhtar (1983) reported that interest costs as a proportion of total inventory carrying cost is high and a one-percentage rise in short term interest rates would decrease aggregate inventory investment by $2 million However, as reported in Blinder and Maccini (1991, p 82), Blinder (1981), Feldstein and Auerbach (1976), and Maccini and Rossana (1981), subsequent studies could not find any effect of interest rates on inventory investments Imperfections in the capital markets and the differential credit ratings of different firms may be the primary reason for this result For, as Ahmed (1998) argued, changes in credit generate an equivalent change in the interest rates which in turn affects the price and output of firms If this is valid then in the presence of constraints on credit the interest rate itself would have no effect Instead, the quantitative limits of credit shocks will affect the inventory investment

firm, it will decide a certain level of output to minimize costs of supplying a given profile of demand over time That is, inventories are accumulated when the market demand is low and drawn down when it is high Inventory policy is retroactive and follows the business cycle Such an inventory policy on the part of the firm implies that the variance of output will be less than the variance of sales [7] The production smoothing model of Holt et al (1960) offered a dynamic generalization of this line of thought For, the production smoothing model postulates that when confronted with increasing marginal costs of production and fluctuations in demand the firm tries to smooth production over time This can be demonstrated by using a simple linear quadratic model where the production costs and inventory holding costs are quadratic [8]

Suppose the cost of production is

$$F + mY_t + qY_t^2$$

Where Y_t is the level of production of the firm

Let the cost of inventory be

$$a + bI_t + cI_t^2$$

where I_t is the level of inventory at the end of time period t

If S_t is the level of sales during the interval of time t it is well known that

[7] Almost without any critical thought such models were tested at macro level as well This gave rise to the feeling that what is true at the micro level must be valid at the macro level as well As will be evident from the next section the Blinder paradox has a genesis in such arguments

[8] Blinder and Maccini (1991a) distinguish between the buffer stock and production smoothing models The production smoothing model deals with the increase in production before the demand is realized The buffer stock model, on the other hand, postulates that the firm anticipates changes in demand and creates a buffer stock (inventory) which can be used to cater to demand as it arises Also see Ashley and Orr (1985)

$I_t = Y_t + I_{t-1} - S_t$

Hence, the total cost of this inventory policy would be

$TC = F + mY_t + qY_t^2 + a + b(Y_t + I_{t-1} - S_t) + c(Y_t + I_{t-1} - S_t)^2$

The optimal choice of Y_t therefore satisfies the equation

$m + 2qY_t + b + 2c(Y_t + I_{t-1} - S_t) = 0$

That is,

$2(q+c)\ Y_t = -\ (m+b) + 2c(S_t - I_{t-1})$

Hence,

$Y_t = \alpha + \beta S_t + \gamma I_{t-1}$

where

$$\beta = \frac{c}{(q+c)} < 1$$

Therefore, it follows that

$V(Y_t) = \beta^2\ V(S_t)$

Hence,

$V(Y_t) < V(S_t)$ always

Thus in the linear quadratic model, introduced by Holt et al (1960), the firm smoothes production in response to the demand shocks with the result that the output will be less variable than sales

The other classic approach is the Metzler model. Metzler (1941) postulated that the firm maintains a desired level of inventories Whenever the demand exceeds anticipations inventories are drawn down The firm's effort to restore the desired level of inventory at some future time period leads to the inventory and business cycles Thus the desired level of inventories and the speed of adjustment are responsible for the inventory and production cycles The basic Metzler model can be represented in the following manner Following the conventional stock adjustment model the desired level of inventory is represented as a function of sales

Hence,

$$(1\ 1) \quad I_t^d = \alpha\, S_t$$

Where I_t^d is the desired level of inventory The changes in the desired level of inventory depend upon the difference between the desired inventory and the inventory at the end of the last time period

Hence,

$$(1\ 2) \quad I_t - I_{t-1} = \delta\,(I^d_t - I_{t-1}) \quad ,\ 0 \leq \delta \leq 1$$

The partial adjustment is, in the usual sense, a response to uncertain sales forecasts From equations (1 1) and (1 2) it can be easily seen that

$$I_t = \alpha\, \delta\, S_t + (1-\delta)\, I_{t-1}$$

Then, since

$$Y_t = S_t + I_t - I_{t-1}$$

$$= S_t + \delta\, (\alpha\, S_t - I_{t-1})$$

$$(1\ 3) \quad Y_t = (1+ \alpha\, \delta\,)\, S_t - \delta\, I_{t\ 1}$$

Since α and δ are both positive it follows that

$$V(Y_t) = (1+ \alpha\, \delta)^2\, V(S_t) > V(S_t)$$

That is, the Metzler model indicates that production is more volatile than sales in general

Can this equation (1 3) imply that $V(Y)<V(S)$? Suppose the estimated regression is $Y_t = a + 1\ 15\ S_t$ and 25 is the standard error of the estimated coefficient of S_t Then, the $2\ \sigma$ limits of the parameter associated with S_t are .65 and 1.65.[9] The Metzler model then implies that $V(Y)<V(S)$ at least under certain conditions

In general, the models in the early literature predicted that $V(Y)<V(S)$ The distinction between unintended and desired (precautionary) levels of inventory was, in itself,

[9] Such possibilities are at the apex of the variance bound tests in West (1985,1995)

inconsequential in so far as this inference is concerned

1 3 The Blinder Paradox

Starting from the studies of Feldstein and Auerbach (1976) and Blinder (1982) many authors demonstrated that the major conclusion of the Holt et al hypothesis does not hold empirically The most significant discrepancy is that $V(Y)>V(S)$ It has also been demonstrated that the phenomenon persists at the macro level, industry level, as well as the firm level [10] The production smoothing argument is generally difficult to sustain except under certain specific circumstances This apparently contradicts the observed empirical regularity As Blinder and Maccini (1991b) remarked "macroeconomists routinely thought of inventories as a destabilizing factor In theory the inventory accelerator created cycles that otherwise might not exist, in practice, GNP was more volatile than sales (GNP less inventory investment) Yet the prevailing micro theory viewed inventories as a stabilizing factor, something a cost minimizing firm should use to smooth production in the face of fluctuating sales Could something that was stabilizing at the micro level destabilize the macro economy?" (p 73) This phenomenon has been described as the Blinder paradox

[10] The result persists even after adjusting for the price and inflation effects, and working with physical data whenever possible For instance, Kahn (1992) found significant evidence against the production smoothing model using physical quantity data

One seemingly simple explanation from the theoretical standpoint is that it is possible to visualize inventory policies to be mostly proactive That is, rather than react to business cycle fluctuations, firms in the monopolistic markets tend to anticipate market conditions and plan production and inventory policies well in advance For all practical purposes the direct cost of such a strategy may far overweigh the goodwill cost of retroactive policies If this interpretation is valid then it follows that business cycle fluctuations can be anticipated and modulated both by appropriate business policies and by suitable credit policies of the central bank The basic question before the economic theorist was what is the nature of economic decision making, by the firms and / or the central bank policy maker which explain this paradox?

Many theories have been put forward to account for this empirical regularity Most of them however do not make any significant changes in the assumptions of the earlier theories [11]The prominent explanations include

(a) demand shocks (Blinder)

(b) cost shocks (Miron and Zeldes)

(c) non-convex costs (Ramey)

(d) (S,s) policies - an extension of non-convex costs (Arrow et al)

(e) precautionary inventories (Kahn)

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[11] As in equilibrium descriptions of Marshall, Walras and Schumpeter, dynamic systems tend to return to a stable state unless disturbed by an external force It is in this spirit that the rational expectations theorists argued that basic changes in the behavior of systems can be explained only by unexpected and random disturbances Similarly, it is increasingly becoming evident that even small non-linearities in the dynamical systems can cause catastrophic behavior in long run equilibrium The new theories are based on these possibilities

(f) Credit Constraints in imperfect markets (Carpenter et al)

These theories will be reviewed in detail in Chapter 2 [12] However, two important points should be emphasized to place the present study in perspective Firstly, most of these theories are essentially a continuation of the earlier tradition In particular, all of them assume that the demand for the products of the firm is exogenous to its decision making process and that the firm has to cater to the demand as it arises Secondly, the increasing marginal cost assumption is also maintained

The central core of each of the alternative explanations can now be highlighted

(a) Blinder's analytical structure is roughly the following Suppose there are demand shocks (random and unanticipated) Assume that the firm is able to backlog orders at some reasonable cost Then, postponing sales in any time period will necessitate increasing production during a subsequent time period This will result in production being more volatile than sales in some cases [13] Note that the basic adjustment is in

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[12]In practice each of these theories provides a sufficient, but not a necessary condition, to explain the Blinder paradox As of now, developing a necessary and sufficient condition is elusive

[13] Production smoothing may also occur in such situations Blinder acknowledges this and allows for the possibility that $V(Y) < V(S)$

production though the firm is also expected to optimize on the level of sales primarily due to the possibility of backlogging orders [14]

(b) In the aftermath of the oil price shocks (due to the formation of OPEC in particular) most of the manufacturing sector experienced significant changes in their costs of production (cost shocks) If they must satisfy the demand as it arises, and keep their costs to the minimum, the only strategy available to them was to produce more when the costs are low and reduce production in periods of high costs For all practical purposes this is the Miron and Zeldes (1988) reasoning about $V(Y)> V(S)$ [15,16]

(c) Ramey (1991) begins with the observation that firms in monopolistic competition operate at less than capacity most of the time Even if the demand for the products is steady varying the levels of production may reduce costs This can be demonstrated as follows

Let

S_t = sales at time $t = A$ (some constant), and

S_{t+1} = sales at time $t + 1 = A$

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[14] The optimization on sales does not imply stabilizing it The total demand over the plan horizon must still be satisfied It will also be argued in the sequel that optimization on sales may be for reasons other than the possibility of backlogging orders

[15] Blinder (1986), studying the effect of cost shocks, concluded that cost shocks can result in a positive covariance between sales and inventory investment This results in $V(Y)>V(S)$

[16] In empirical practice shocks associated with several components of cost have been significant in explaining the phenomenon See, for instance, Eichenbaum (1989)

That is, the market demand is steady Let the production costs be non-convex In particular, if the marginal costs are decreasing, a large output at time t may reduce costs to a point where the total costs of satisfying the demand in these two periods of time is lower even after inventory costs are accounted for This can be illustrated as follows

Consider two alternative production policies

Policy 1 Produce $Y = A$ in both the time periods

Policy 2 Produce $Y_1 = A + \delta$ and $Y_2 = A - \delta$ thus carrying an inventory δ for one time period

The costs of these policies can be compared to determine the superiority of one over the other Note that

C_1 Cost of policy 1 = $2C(A)$

While

C_2 Cost of policy $2 = C(A + \delta) + C(A- \delta) + f(\delta)$

Where $f(\delta)$ is the inventory cost

It can now be inferred that

$C_2 = 2C(A) + \delta^2 C_{11} (A) + f(\delta) < 2C(A) = C_1$

if the marginal cost is decreasing, i e , $C_{11} < 0$ and $f(\delta)$ is not very large

Clearly, $V(Y)$ under policy 2 is positive while $V(S) = 0$ That is, when the costs are non-convex there is a possibility that the optimal production plans imply $V(Y) > V(S)$

(d) The (S,s) model of inventory is a special case of the non-convex cost specification For, when the costs are non-convex, the firm finds it optimal to arrange production to stock rather than to order In particular, the firm produces an amount S of output whenever the inventories reach a level s or lower such that S caters to sales over the time horizon $(0,T)$ The fixed time T is often referred to as the regeneration point [17] If this pattern of production can be shown to be optimal, at least under certain assumptions, it follows that $V(Y)>V(S)$ Automobile assembly lines offer a typical example of this nature

(e)When confronted with demand uncertainty firms are more likely to hold some precautionary inventories to avoid goodwill costs They do this to circumvent the inability to adjust output ex post, and/or stabilize market demand (this happens whenever a firm, which can supply on demand, is considered by the customer to be more reliable See, for example, Ware (1985)) Since such precautionary demand for inventory is always a positive fraction of sales it follows that $V(Y)>V(S)$ [18]The analytical structure of Kahn (1987, 1992) is basically dependent on this logic

(f) In the neoclassical tradition, which maintains the dichotomy between the real and financial decisions, it is assumed that the financial markets are perfect in the sense of Modigliani and Miller (1958) Hence, the interest rates on short term borrowings for working capital finance is considered as the only determinant of inventory investment

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[17] Refer to Manne and Veinott (1967) for the original specification of the regeneration point theorem with arbitrary demand patterns

[18] Note that inventories do not accumulate indefinitely Instead, they vary with S However, the variation in output exceeds that in sales

However, as Gurley and Shaw (1960) and Vickers (1968, 1987) noted, there will be a significant interaction between the real and financial decisions of the firm when the capital markets are imperfect For, (a) internal funds are less expensive than external finances, (b) the access to and the cost of external finances depend on the collaterizable value of the assets of the firm, and (c) the monetary and credit policies of the central bank See, for example, Guariglia and Schianterallı (1998), Kashyap et al (1994), and Bernanke et al (1996) Hence, another very significant aspect of the problem being dealt with is the impact of financial arrangements, costs associated with them and the constraints they place on production and inventory decisions

To reduce the argument to its essential details consider a firm that has an accurate forecast of its demand conditions If there are no financial constraints the firm will decide a profile of production inventory decisions to minimize the cost of satisfying the demand This will clearly define its credit requirements over time Now suppose that there is either an unanticipated or anticipated credit crunch during a certain time period Then the firm cannot produce the output it desires It is natural to expect such firms to produce more when the credit is available and reduce it if there is a shortage Hence, for all practical purposes, a credit constraint may make $V(Y)>V(S)$ See, for example, Kuznets (1964), Freidman and Kuttner (1993), Cuthbertson and Gasparro (1993), and Fazzari and Peterson (1993), and Kashyap et al (1993,1994)

Two points should be reiterated Firstly, all the existing studies assume that the firms must satisfy the demand as it arises and the explanation for the Blinder paradox must be

subject to the possibilities which make the production variations essential and more volatile Secondly, the theories attempt to establish that the volatility of production relative to sales occurs primarily at the micro level This carries over to the macro level in a natural way Hence, the micro-macro instability distinction in the Blinder paradox is artificial and gets an exaggerated emphasis only if the original production smoothing arguments of the previous section are maintained

1 4 Decisions under Monopolistic Competition

Up to this point in the analysis almost all studies assumed that firms under monopolistic competition experience significant losses if they cannot satisfy demand as it materializes [19] In actual practice, as some studies tried to establish, firms would try to stabilize demand, and adjust production inventory decisions to maintain their market share [20] It is therefore realistic to postulate that the firms consider at least a part of the random demand at any given point of time as transitory and hence does not constitute a steady trend It is therefore very likely that firms tend to ignore at least a part of the

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[19] Even the Blinder argument that orders can be backlogged postulated that it can be done only at some cost and the demand must be satisfied sooner or later

[20] In particular, Rao and Rastogi (1997) provided theoretical as well as empirical support to the following In decentralized organizations the marketing manager sets a sales target (usually somewhat low so that it can be definitely fulfilled) and sets a high advertising target to defend it Similarly, the production manager chooses high enough production and inventory levels so that the sales target can be fulfilled In most cases this behavior is exhibited because the managers are judged by their performance

uncertain (or transitory) component of demand [21] Given the increasing marginal cost of production and holding inventory firms would also find it optimal to maintain a steady demand or market share In other words, the emphasis of most of the studies on the high volatility of market demand is exaggerated For, even when the overall market demand for the industry, or a firm at the micro level, is highly variable any one firm is unlikely to chase the uncertain market [22] Instead, any realistic decision making process under monopolistic competition tends to keep the variability of sales to relatively low levels Firms will aim to achieve as high a level of demand or market share but within the limits of their production capacity They are unlikely to be overly greedy

Consider the production choices It is well known that at or close to long run group equilibrium, almost all the firms have excess capacity Consequently, if the demand fluctuations require it, they can increase production at a decreasing average cost In fact, such a threat also puts a limit on other firms trying to increase their market in the short run where there is random increase in demand For all practical purposes it can be argued

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[21] For illustrative purposes consider the following On any given day a customer may enter a given retail shop with the intention of buying a specific product One possibility is that no purchase is actually made Another possibility is that even if a purchase is made the customer may not return to it for any repeat purchase In general, only a fraction of the customers visiting the shop on a given day are loyal buyers over time

[22] In the aftermath of the OPEC oil prices most of the Canadian firms (which were not a part of OPEC) did not allow their federal government to impose quantitative limits on production, price controls or significant taxes on windfall rents They thought that they should be allowed to make as much profit as market allows As the history revealed many companies went bankrupt when OPEC prices did not increase as much as expected

that there is, within certain limits, ex post production flexibility See, for instance, Aiginger (1985, 1987), and Flacco and Kroetch (1986)

The firms are also compelled to utilize this production flexibility when confronted with credit constraints For, as pointed out in the previous section, production must adjust based on the availability of credit

The following hypothesis appears to be theoretically justifiable and empirically verifiable The basic proposition of the Blinder paradox is that *V(Y)>V(S)* Existing theories postulate that *V(S)* is high, exogenously given, and that the firm cannot do anything to change it Hence, the theories explaining the Blinder paradox look for ways of explaining a high *V(Y)* On the contrary, the above arguments suggests that the firm will keep *V(S)* low by choice, and external conditions – like cost shocks, non-convex costs, and financial constraints – explain the volatility of *V(Y)* Small perturbations in demand do not produce major business cycles But even small changes in the cost and credit constraints may do so [23] Hence, unlike in the previous theories, it is more realistic to expect that *V(S)* is low and *V(Y)* is significant That is, firms generally tend to stabilize

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[23] Since the Blinder framework appears fairly general it may be argued that it does not contradict this hypothesis However, suppose the opportunity value of holding inventory is low Then, the firm may forgo sales and keep V(S) stable The firm does not then have any compulsion to change production very often unless some other exogenous change is postulated That is, production stabilization is more likely and *V(Y)<V(S)* Precautionary inventories, cost shocks, and/or financial constraints play an essential role in resolving the Blinder paradox Is it necessary that the value of holding inventories should be low for the firm to stabilize S? The argument of the present study is that it can happen whatever may be the value of inventory holding Of course, there are no claims being made about the universality of the alternative argument or that none of the existing theories is valid The alternative proposed here is yet another sufficient condition like all others before it

sales, vary production depending on the capacity and credit constraints [24] This reversal of the argument is the crux of the present thesis It does not negate any of the existing explanations of the Blinder Paradox but provides a new theoretical and empirical emphasis

1 5 Organization of the Study

With the foregoing background in perspective the rest of the study is organized as follows

Chapter 2 synthesizes all the neoclassical explanations of the production volatility hypothesis using the Blinder model as the unifying theory

Chapter 3 considers the effect of imperfect capital markets and extends the Blinder framework by appending a balance sheet identity to incorporate the financial constraints This is the core theoretical chapter of the present study

Turning to the empirical work of the proposed hypothesis, chapter 4 describes the sources of data, the construction of variables, and the expectations in the computational process

[24] Ironically whenever the alternative is empirically valid the Blinder approach to the resolution of the paradox does not hold Even so, which combination of the many theoretical versions is relevant in the context of any one firm or industry remains an empirical question

Chapter 5 outlines the empirical experiences How extensive is the validity of the Blinder stylized fact? Is the Ramey argument on non-convex costs valid ? If so, how useful is it in resolving the paradox? How useful are the Blinder variants? In general, this chapter provides an empirical appraisal of the hypothesis regarding the financial constraints

Chapter 6 offers an overview of the study and highlights a few of the limitations

CHAPTER 2

The Essential Background

2 1 Modifications of Production Smoothing

There is a vast amount of empirical research justifying the production smoothing model though a large body of the theoretical literature supports the Blinder paradox The following observations are pertinent

Beason (1993), using the physical quantity data on production, sales and inventories for 29 selected Japanese industries, found that the production inventory decisions of the firms were consistent with the production smoothing model Since the Japanese firms are less able to vary employment in the face of fluctuating demand these firms have an added incentive for smoothing production

Similarly, Fair (1989) used price deflated monthly data for seven industries The results strongly support the production smoothing hypothesis He concludes that "the production smoothing model is alive and well" and the lack of good data has been responsible for the erroneous tests of the production smoothing hypothesis

Lai (1991) examined the degree of bias when aggregate data are used for testing the production smoothing hypothesis Krane and Braun (1991) considered diaggregated

physical product data and found that production is smoother than shipments in about two thirds of 38 industries studied Ghali (1987) carried out a similar exercise He showed that the seasonality and aggregation of data distorts[1] tests of the production smoothing hypothesis [2]

For all practical purposes, questions regarding the nature of the data used, the type of industry, and the procedures adopted in calculating *V(Y)* and *V(S)* make significant differences in determining which hypothesis is valid It is therefore not surprising to find Lovell (1961, 1993), Fair (1989), and others insist that $V(Y)<V(S)$ This option will be kept open in the present study though the main focus is on the explanation of the Blinder paradox

Similarly, some studies made an attempt to show that a few minor changes in assumptions may still allow the production smoothing model to explain the greater volatility of production relative to sales Naish (1994, 1998) has made amendments to the linear quadratic model to show that if the demand shocks are unanticipated and take a specific form then they would make the volatility of production exceed that of sales He demonstrated that if the marginal costs are constant then there is no advantage of production smoothing It is preferable to make $Y = S$ If changes in S are expected to

[1] Some studies such as Miron and Zeldes (1988) do not support this observation
[2] Kashyap and Wilcox (1993) documented a remarkable feature General Motors produces in eight months all the output it sells in one year How should *V(Y)* be calculated? If it is calculated over eight months then $V(Y) > V(S)$ The inequality is reversed otherwise

persist and Y is planned accordingly the expected S need not always materialize This causes $V(Y) > V(S)$ [3]

Eichenbaum (1984) formulated a dynamic rational expectations model in which finished goods inventory and employment of labor, sales and price are simultaneously determined He examined the role of inventories as a buffer stock, to study the interrelationships between inventories and employment He assumes that the cost of adjusting inventories is related to, but is substantially higher than the firm's laborforce His study favors the production smoothing model Eichenbaum's (1989) study compared the production level smoothing and the production cost smoothing He concluded that the variance of production exceeds the variance of sales in most manufacturing industries because the production cost smoothing role of inventories was found to be quantitatively more important than the production level smoothing role of inventories

In a general sense the argument is that the expected changes in demand can be accommodated by production smoothing It is only unexpected changes in demand, cost, or credit conditions which compel firms to change production away from the rationality of production smoothing One of the many reasons for this may be the goodwill cost of

[3] An empirical exercise of the behavior of inventories was conducted by Blanchard (1983) for the American automobile industry He explains the production behavior by utilizing the assumption of intertemporal optimization with rational expectations He considers the cost of production and the cost of being away from the target inventory (the cost of target inventory being a function of the current sales revenue) He draws the conclusion that although the inventory behavior depends upon the characteristics of the demand process, inventory behavior is destabilizing and the variation of production is greater than that of sales

not fulfilling demand as and when it arises

A somewhat different approach to goodwill cost was presented in Singh and Rao (1998) Their study showed that production smoothing model of inventories can provide an explanation for the greater volatility of production over sales if the goodwill costs of being out of stock are properly specified Their model can be demonstrated in the following manner

Assume that the cost of changing the level of production is

$PC = c(Y_t - Y_{t-1})^2,\ c>0$

and

Inventory cost is

$IC = fI_t{*}^2 + ap(Y_t + I_{t-1} - S_t - I_t{*})^2,\ f > 0 \text{ and } a > 0$

Where

$I_t{*}$ = desired level of inventory

S_t = market demand at time t

Y_t = level of production

I_t = actual inventory

p = probability of having a positive unintended inventory

Let the perceived cost of goodwill be

$GC = b(1-p)\ (S_t + I_t{*} - Y_t - I_{t-1})^2 - 2gI_t{*}S_t,\ b > 0,\ g > 0$

If

$S_t + I_t^* > Y_t + I_{t-1}$

it will be expected that there are increasing marginal costs of goodwill However, an increase in I_t^* is likely to reduce the goodwill costs That is, the specification that I is positive is essential

The choice of Y_t and I_t^* which will minimize the total cost for a given S_t is given by

$$c(Y_t - Y_{t-1}) - a_1(S_t + I_t^* - Y_t - I_{t-1}) = 0$$

and

$$fI_t^* + a_1(S_t + I_t^* - Y_t - I_{t-1}) - g S_t = 0$$

where

$$a_1 = ap + b(1-p)$$

The precautionary demand for inventories is therefore

$$I_t^* = f^*(Y_t - I_{t-1}) + a^*S_t$$

Where

$$f^* = \frac{a_1 c}{(a_1 c + cf + a_1 f)}$$

and

$$a^* = \frac{(a_1 g + gc - a_1 c)}{(a_1 c + cf + a_1 f)}$$

Correspondingly, the optimal choice of output is given by

$$Y_t = c^{**}Y_{t-1} + a^{**}S_t - f^{**}I_{t-1}$$

where

$$c^{**} = \frac{c(a_1 + f)}{(a_1 c + cf + fa_1)}$$

$$a^{**} = \frac{a_1(g + f)}{(a_1 c + cf + fa_1)}$$

and

$$f^{**} = \frac{fa_1}{(a_1c + cf + fa_1)}$$

Hence,

$$V(Y_t) = a^{**2}V(S_t)$$
$$> V(S_t) \text{ if } a_1 g > c(a_1 + f)$$

Clearly, whenever the advantages of goodwill are high relative to a_1, c_2, and f as stated above there will be significant precautionary inventory This also explains the persistence of $V(Y_t)>V(S_t)$

2 2 The Blinder Framework and its Variants

In the existing literature several theories have been advanced as possible explanations of the Blinder Paradox For all practical purposes the following theories are significant

(a) demand shocks

(b) cost shocks

(c) non-convex costs

(d) (S,s) inventory policies

(e) desired level of inventories

(f) financial constraints

Each of these theories was developed from different premises Hence, on occasions, they seem to lack coherence and appear contradictory However, this is not true

In this chapter an attempt is made to unify the existing economic theories within the Blinder model framework In a nutshell the unification is made possible by the

recognition that the balance sheet identity encompasses all the basic variations with respect to

(a) the sources of disturbance which are firm specific and induced by the nature of the product market, cash flow weakness (or generally the availability of internal finances), recessionary conditions in the product markets, and the firm's ability to raise adequate external finances from borrowings,

(b) monetary and credit policy induced disturbances, and

(c) structural rigidities and precommitments which hamper efficient adjustments in the firm decision making process

2 3 Blinder Model

Blinder (1982) initiated the argument in the following way If the firm plans production and sales apriori, i e , before the random demand is realized, inventory accumulation satisfies the equation

$$\frac{dI}{dt} = Y - S$$

Where Y = level of production

S = volume of sales

I = stock of inventory at the end of time period t, and

the differentiation is with respect to time

Blinder also assumes that negative values of inventories are possible, i e , the firms can backlog orders at a cost similar to the inventory cost [4] See, for instance, Blinder (1982, p 337), and Schutte (1983, p 815) The firm is postulated to maximize the value

$$V = \int_{0}^{\infty} e^{-rt}[R(S) - C(Y) - f(I)]dt$$

where

R(S) = revenue of the firm from the sale of S

C(Y) = cost of production

f(I) = cost of inventory holding

subject to

$$\frac{dI}{dt} = Y - S$$

Then, the optimal values of *Y* and *S* can be defined by utilizing Pontryagin et al (1964) maximum principle Construct the Hamiltonion

$$H = e^{-rt} [R(S) - C(Y) - f(I)] + \lambda [Y - S]$$

where λ can be interpreted as the present discounted value of profit expected from holding a unit of inventory

[4] However, this is not a crucial assumption since respecifying these two aspects separately and taking the expected values does not alter the results significantly This will be taken up again in the sequel

The optimal values of Y and S satisfy the equations

$$\frac{d\lambda}{dt} = -\frac{\partial H}{\partial I} = e^{-rt} f_1(I)$$

$$\text{(2 1)} \qquad \frac{\partial H}{\partial Y} = 0 = \lambda - e^{-rt} C_1(Y)$$

$$\text{(2 2)} \qquad \frac{\partial H}{\partial S} = 0 = -\lambda + e^{-rt} R_1(S)$$

Then Fig 1, obtained from Blinder (1982, p 335), illustrates the determination of the optimal Y and S For, from equation (2 1) the optimal Y is at the intersection between $\lambda\, e^{rt}$ and MC Similarly, the optimal S satisfies the equation

$R_1(S) = \lambda\, e^{rt}$

Let the demand shocks be represented by ε so that

$MR = R_1(S) + \varepsilon$

Clearly, the value of λ is a function of ε

Then, from equation (2 1) it follows that

$$C_{11} \frac{\partial Y}{\partial \varepsilon} = e^{rt} \frac{\partial \lambda}{\partial \varepsilon}$$

so that

$$\frac{\partial Y}{\partial \varepsilon} = \frac{1}{C_{11}(Y)} e^{rt} \frac{\partial \lambda}{\partial \varepsilon}$$

Similarly, the variation in the optimal sales can be represented by

$$\frac{\partial S}{\partial \varepsilon} = -\frac{1}{R_{11}(S)} \left(1 - e^{rt} \frac{\partial \lambda}{\partial \varepsilon} \right)$$

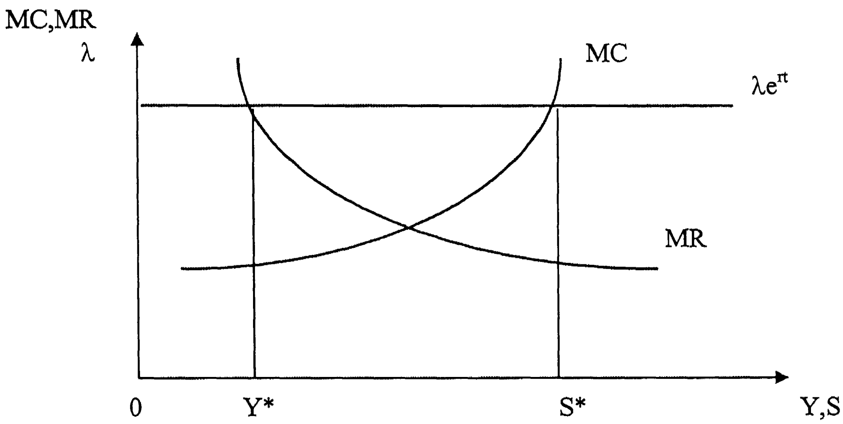

Fig 1 Optimal production and sales level

Hence, if $e^{rt}\frac{\partial\lambda}{\partial\varepsilon}$ is close to zero, the demand shocks cause a low output response but a large sales response resulting in $V(Y) < V(S)$ On the other hand, if $e^{rt}\frac{\partial\lambda}{\partial\varepsilon}$ is close to 1, $V(S)$ is negligible while $V(Y)$ is large That is, $V(Y)>V(S)$ As Blinder[5] (1982, pp 335) suggests $\frac{\partial\lambda}{\partial\varepsilon}$ would be large if the demand shocks are persistent Hence, the persistence of demand shocks offers one possible explanation of the greater volatility of production in comparison to sales [6]

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[5] Suppose S_t is taken to be exogenous in the Blinder framework That is, the random demand must be satisfied as and when it occurs Then the only choice available to the firm is the production level
The optimal solution can now be shown to satisfy the equations

(1) $\frac{d\lambda}{dt} = e^{rt} f_1(I)$

and

(2) $\lambda = e^{rt}\ C_1(Y)$

Differentiating (2) with respect to t and eliminating λ results in

(3) $r\ C_1(Y) = -f_1\ (I)$

The question now is whether $dY / dS > 1$
To begin with observe that $I_t = Yt - S_t + I_t - 1$ so that $\partial I/\partial S = -1$

Differentiating equation (3) with respect to S indicates that,

(4) $r\ C_{11}\ (y)\ (dY / dS) = f_{11}\ (I)$

Consequently, $dY / dS = f_{11} / rC_{11} > 1$ *iff* $f_{11} > r\ C_{11}$, i e, if the marginal cost of inventory holding is far in excess of the production cost incurred in the absence of inventory policy This is the spirit of Blinder's (1982, p 33) statement that " $d\lambda$ / $d\varepsilon$ will be larger when goods are more difficult to inventory "

[6] This result holds even if the demand shocks are replaced by anticipated changes in demand For, it can be readily verified that replacing the demand curve by p(S,ε), where ε is a deterministic shift parameter, will not alter the results In addition, if the elasticity of demand is very small the changes in S as ε varies will be negligible In other words, firms in monopolistic competition and oligopoly depend mostly on generating brand loyalty and low elasticity of demand rather than make adjustments in S regularly This aspect will be highlighted once again in Chapter 3

Note that up to this point in the analysis the forces determining λ have not been considered explicitly [7] Similarly, the role of the equation

$$\frac{d\lambda}{dt} = e^{-rt} f_1(I)$$

and the influence of the inventory costs on the relationship between *V(Y)* and *V(S)* has not been explored This can be approached in three steps

To begin with note that an ex ante increase in the marginal cost of inventory would imply that the discounted present value of profits expected from a unit of inventory holding will decrease That is, ex ante λe^{rt} will fall as f_1 increases Referring to Fig 2, it follows that the equilibrium level of inventory decreases from AB to A'B' [8]

However, as Blinder (1982, p 335) pointed out, the equilibrium value of λ increases whenever the products of the firm are difficult to inventory The $d\lambda/dt$ equation in the Blinder model is in consonance with this observation It is therefore necessary to examine the reasons for the ex post λ increasing while it decreases ex ante

---

[7] Within the Blinder framework the determination of λ will depend on the other constraints imposed on the optimization problem Details of the analysis can be found in Arvan (1982), and Arvan and Moses (1982), Feichtinger and Hartl (1985), and Spulber (1985)

[8] Eichenbaum (1984), Spulber (1985), and Beason (1993), and Maccini and Rossana (1984) also noted that the inventory accumulation would decrease as the inventory holding costs rise

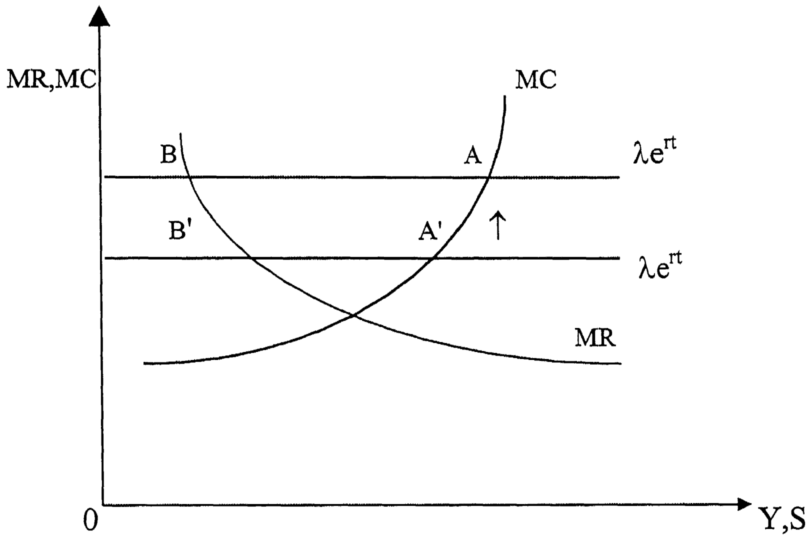

Fig 2 Impact of an increase in inventory cost ex ante

Referring to Fig 3, it is obvious that $\frac{\partial\lambda}{\partial t}e^{rt}$ has a negative slope due to the increasing marginal cost of inventory holding The firm compares the discounted present value of the expected returns from the holding of a unit of inventory with the marginal costs Hence, the equilibrium is at E where $\frac{\partial\lambda}{\partial t}e^{rt} = f_1(I)$ If $f_1(I)$ increases as the firm experiences an ex ante reduction in $\frac{\partial\lambda}{\partial t}e^{rt}$ as noted earlier However, since the firm is generally operating under conditions of monopolistic competition some part of the increase in $f_1(I)$, but not the entire amount, can be transferred to the consumer It follows that the reduction in $\frac{\partial\lambda}{\partial t}e^{rt}$ will be proportionately less than in $f_1(I)$ itself The resulting equilibrium value of λ will be larger This is the basic reason for Blinder's assertion that $d\lambda / d\varepsilon$ increases if the commodity is more difficult to inventory

One further observation is important Note that Blinder (1982) allows for a negative inventory However, no distinction is drawn between the marginal costs associated with a reduction in inventory and addition to order backlog As Schutte (1983) pointed out, "The cost of holding inventory is (assumed to be) symmetric around an arbitrary point" Consequently, an increase in the inventory holding cost does not lead to a decrease in λ because the orders can be backlogged and produced when the inventory costs fall

Secondly, as Eichenbaum (1984) remarked, the value of λ depends primarily on the production costs and the labor costs Inventory costs may have only a marginal effect on

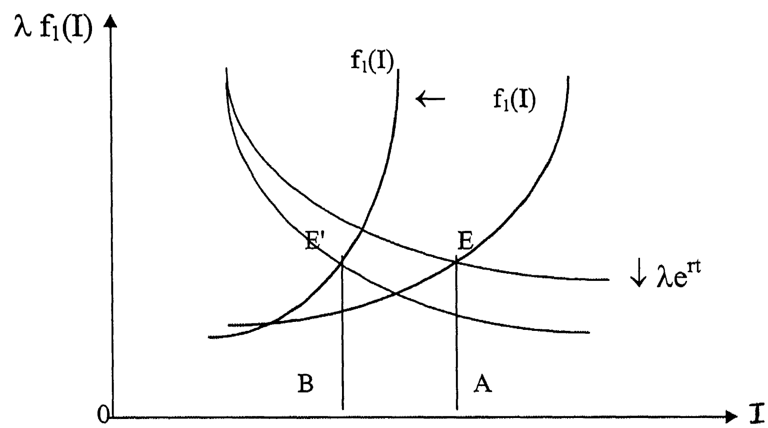

Fig 3 Impact of an increase in inventory cost ex post

λ That is, no significant reduction in λ is expected even if the marginal cost of holding inventories increases

It can now be shown that the increase in inventory cost and the resulting increase in λ still preserve the property $V(Y) > V(S)$ Reconsider the Blinder equations

$\lambda e^{rt} = C_1(Y)$

$\lambda e^{rt} = R_1(S)$

Note that $\partial\lambda / \partial f_1 > 0$

Differentiating these equations successively with respect to f_1 it can be verified that

$$\frac{\partial Y}{\partial f_1} = \frac{1}{C_{11}(Y)} \frac{\partial \lambda}{\partial f_1} e^{rt} > 0$$
$$\frac{\partial S}{\partial f_1} = \frac{1}{R_{11}(S)} \frac{\partial \lambda}{\partial f_1} e^{rt} < 0$$

Therefore, it follows that [9]

$$\frac{\partial Y}{\partial f_1} > \frac{\partial S}{\partial f_1}, \text{ and}$$
$$V(Y) > V(S)$$

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[9] For analytical completeness consider the possibility that $\partial\lambda / \partial f_1 < 0$ Then, $\partial Y / \partial f_1 < 0$ In such a case $V(S) > V(Y)$ Intuitively this is plausible For, if the inventory holding is expensive the firm tends not to hold inventory It moves towards $V(Y) = V(S)$ Hence, there is a possibility that the difference between $V(Y)$ and $V(S)$ will be reduced

Fundamentally, an increase in $f_I(I)$ has two aspects (a) it increases the equilibrium value of λ, and (b) it preserves the possibility of $V(Y) > V(S)$ However, the reduction in the equilibrium value of I suggests that there will be a reduction in the difference between $V(Y)$ and $V(S)$

For, incorporating demand shocks in the equilibrium conditions alluded to above and noting that $\frac{\partial \lambda}{\partial I} < 0$ in equilibrium it can be argued that $\frac{\partial}{\partial \varepsilon}\left(\frac{\partial \lambda}{\partial I}\right) > 0$ Further, the more persistent the demand shocks the greater will be the expected returns from the last unit of inventory holding Simple differentiation then indicates that

$$
\begin{aligned}
\frac{\partial}{\partial I}\left[\frac{\partial Y}{\partial \varepsilon} - \frac{\partial S}{\partial \varepsilon}\right] &= \frac{1}{C_{11}} e^{rt} \frac{\partial}{\partial I}\left(\frac{\partial \lambda}{\partial \varepsilon}\right) - \frac{1}{R_{11}} e^{rt} \frac{\partial}{\partial I}\left(\frac{\partial \lambda}{\partial \varepsilon}\right) \\
&= e^{rt} \frac{\partial}{\partial I}\left(\frac{\partial \lambda}{\partial \varepsilon}\right)\left(\frac{1}{C_{11}} - \frac{1}{R_{11}}\right) > 0
\end{aligned}
$$

Hence, as the level of inventory holding decreases the difference between $V(Y)$ and $V(S)$ will be reduced In sum, while increasing marginal costs of inventory holding do not negate the Blinder proposition they do suggest that the gap between $V(Y)$ and $V(S)$ will be narrowed

2 4 Cost Shocks

Mıron and Zeldes (1988) argue that ıf the seasonal fluctuatıons ın demand happen to be the most ımportant reason for the greater varıabılıty of productıon relatıve to sales then seasonally adjusted data should not exhıbıt thıs property However, they observe that the phenomenon persısts even after seasonal adjustment Consequently, they suggest that further explanatıon ıs necessary

Mıron and Zeldes (1988) study the varıabılıty of productıon and sales ın ındustrıes whıch experıence cost shocks [10] In the presence of cost shocks Mıron and Zeldes expect firms to produce more when the costs are low and reduce the level of productıon when costs are hıgh Thıs ıs another reason for the greater varıabılıty ın productıon

Thıs proposıtıon of Mıron and Zeldes (1988) can be ıncorporated ınto the Blınder framework Suppose η ıs the cost shock such that the margınal cost MC changes to

$MC = C_1(Y) + \eta$

Dıfferentıatıng equatıons (2 1) and (2 2) wıth respect to η would yıeld

(2 3) $$\frac{\partial S}{\partial \eta} = \frac{1}{R_{11}} e^{rt} \frac{\partial \lambda}{\partial \eta}, \text{ and}$$

(2 4) $$\frac{\partial Y}{\partial \eta} = \frac{1}{C_{11}} \left(e^{rt} \frac{\partial \lambda}{\partial \eta} - 1 \right)$$

[10] In some recent studıes such as Carey (1996), and Clark (1993, 1997) the source of cost shocks have been ınvestıgated

Hence, if $e^{rt}\frac{\partial \lambda}{\partial \eta}$ is close to 1 then, $\frac{\partial Y}{\partial \eta} = 0$, and $\frac{\partial S}{\partial \eta} > 0$

Thus, $V(S) > V(Y)$

On the other hand, $V(Y) > V(S)$ if $\frac{\partial \lambda}{\partial \eta}e^{rt}$ is close to 0 [11]

As in the case of demand shocks it can be shown that the increasing marginal cost of inventory holding tends to decrease the difference between the $V(Y)$ and $V(S)$ For, as before, the equilibrium value of λ increases while reducing the ex post choice of the inventory level I Similarly, it can be argued that $\frac{\partial}{\partial I}\left(\frac{\partial \lambda}{\partial \eta}\right) > 0$ Differentiating the equation

$$\frac{\partial Y}{\partial \eta} - \frac{\partial S}{\partial \eta} = \frac{1}{C_{11}}\left(\frac{\partial \lambda}{\partial \eta}e^{rt} - 1\right) - \frac{1}{R_{11}}\frac{\partial \lambda}{\partial \eta}e^{rt}$$

partially with respect to I it follows that,

$$\frac{\partial}{\partial I}\left(\frac{\partial Y}{\partial \eta} - \frac{\partial S}{\partial \eta}\right) = \left(\frac{1}{C_{11}} - \frac{1}{R_{11}}\right)e^{rt}\frac{\partial}{\partial I}\left(\frac{\partial \lambda}{\partial Y}\right) > 0$$

[11] Observe that if the cost shocks are persistent the costs of conducting a given volume of sales, even after making the Miron and Zeldes (1988) adjustment, may be sufficiently high to a point where maintaining sales and market shares cannot be profitable In such a case sales may decrease more than production disturbing the validity of the Miron and Zeldes (1988) proposition See for instance, Glick and Whilborg (1985, p 572)

Hence, as before, the difference between $V(Y)$ and $V(S)$ reduces as the marginal cost of inventory holding increases

Blanchard (1983), Eichenbaum (1984, 1989), and Glick and Whilborg (1985) examined the influence of both the demand and the cost shocks simultaneously Reconsider the Blinder (1982) equations

$\lambda e^{rt} = R_1(S) + \varepsilon$, and

$\lambda e^{rt} = C_1(Y) + \eta$

Under these conditions it will be expected that

$\lambda = \lambda(\varepsilon, \eta)$,

$S = S(\varepsilon, \eta)$, and

$Y = Y(\varepsilon, \eta)$

Then, differentiating the two equations totally with respect to ε and η results in

$$
\begin{aligned}
dS &= \left(\frac{\partial S}{\partial \varepsilon}\right) d\varepsilon + \left(\frac{\partial S}{\partial \eta}\right) d\eta \\
&= \frac{1}{R_{11}(S)}\left[1 - \frac{\partial \lambda}{\partial \varepsilon} e^{rt}\right] d\varepsilon + \frac{1}{R_{11}(S)} \frac{\partial \lambda}{\partial \eta} e^{rt} d\eta, \text{and} \\
dY &= \frac{1}{C_{11}(Y)} \frac{\partial \lambda}{\partial \varepsilon} e^{rt} d\varepsilon - \frac{1}{C_{11}(Y)}\left[1 - \frac{\partial \lambda}{\partial \eta} e^{rt}\right] d\eta
\end{aligned}
$$

If both the demand and the cost shocks persist, i e ,

$$\frac{\partial\lambda}{\partial\varepsilon}e^{rt}=1 \text{ and } \frac{\partial\lambda}{\partial\eta}e^{rt}=1$$

It follows that

$$dS=\frac{d\eta}{R_{11}(S)}, \text{ and } dY=\frac{d\varepsilon}{C_{11}(Y)}$$

consequently,

$$dY > dS \qquad \text{iff} \frac{d\varepsilon}{C_{11}(Y)} > \frac{d\eta}{R_{11}(S)}, \text{or}$$

$$d\eta > \frac{R_{11}(S)}{C_{11}(Y)}d\varepsilon$$

justifying $V(Y)>V(S)$

That is, as Glick and Whilborg (1985, p 572) put it, "Output may fluctuate more than sales if cost disturbances dominate demand disturbances "[12]

2 5 Non Convex Costs

As discussed in the previous section Ramey (1991) considers the case of industries, such as automobiles, where the average cost is decreasing and the bulk production is more

[12] It can be readily verified that the Blinder (1982), and Miron and Zeldes (1988) results are embedded in this specification

profitable The production in some industries like automobiles is conducted in a few months of the year, whereas the sales are spread throughout the year This leads to the greater volatility of production as compared to sales

The non-convexity of costs can be examined within the Blinder framework Note that, if the cost function *C(Y)* is non convex the second order conditions for the optimal choice of Y in this model cannot be satisfied Straightforward differentiation is therefore not possible

Hence, to construct the optimal solution rewrite the discounted present value of profit as

$$(2\ 5) \qquad \int_0^{\infty} e^{-rt} R(S)dt - \int_0^{\infty} e^{-rt}[C(Y) + f(I)]dt$$

For a given S the firm tries to minimize the sum of the production cost and the inventory cost

In general, the production at time t is equal to sales plus some amount of change in inventory say δ That is,

$Y = S + \delta$

Hence,

(2 6) $$\int_0^\infty Y dt = \int_0^\infty S dt + \int_0^\infty \delta dt$$

(2 7) $$\int_0^\infty \delta dt = 0$$

For, the firm has no value for its inventory beyond the plan horizon The firm tries to minimize

$\int_0^\infty e^{-rt} C(S+\delta) dt + \int_0^\infty e^{-rt} f\left(\int_0^t \delta dt \right) dt$, where $\int_0^t \delta \mathrm{dt}$ = stock of inventory at the end of time t

in its choice of the production plan The relative costs of the two production plans alluded to earlier may now be compared ignoring the inventory costs to begin with

Note that the costs of adopting policy 1 are

$$\int_0^\infty e^{-rt} C(S) dt$$

while the cost of policy 2 can be written as

$$\int_0^\infty e^{-rt} C(S+\delta) dt$$

The superiority of the inventory policy under non convex costs can be established if it is possible to show that

$$\int_0^\infty e^{-rt} C(S)dt > \int_0^\infty e^{-rt} S(S+\delta)dt$$

The costs of policy 2 can be restated as follows

$$\int_0^\infty e^{-rt} C(S+\delta)dt$$
$$= \int_0^\infty e^{-rt} \left[C(S) + \delta C_1(S) + \frac{1}{2}\delta^2 C_{11}(S) \right] dt$$
$$= \int_0^\infty e^{-rt} C(S)dt + \int_0^\infty e^{-rt} \delta C_1(S)dt + \frac{1}{2}\int_0^\infty e^{-rt} \delta^2 C_{11}(S)dt$$

However,

$$\int_0^\infty e^{-rt} \delta C_1 S(dt) = e^{-rt} C_1(S) \int_0^\infty \delta dt - \int_0^\infty \left(\int_0^\infty \delta dt \right) \frac{d}{dt}\left[e^{-rt} C_1(S) \right] dt$$

Since,

$\int_0^\infty \delta dt = 0$, it follows that

$$\int_0^\infty e^{-rt} \delta C_1(S)dt = 0$$

Therefore, it can be concluded that

$$\int_0^\infty e^{-rt} C(S+\delta)dt = \int_0^\infty e^{-rt} C(S)dt + \frac{1}{2}\int_0^\infty e^{-rt} \delta^2 C_{11}(S)dt$$
$$< \int_0^\infty e^{-rt} C(S)dt$$

whenever $C_{11}(S) < 0$, or the costs are non-convex It can therefore be inferred that the firm pursues production plan 2 and consequently $V(Y) > V(S)$ This result remains valid so long as the inventory costs do not neutralize the production cost advantages

2 6 Summing up

A review of the existing literature indicates that

(a) The empirical validity of $V(Y) > V(S)$ depends upon (1)how Y and S are measured, and (2) the time horizon over which the variances are computed The Blinder paradox is not a universal phenomenon though it is recorded in many contexts

(b) The production smoothing model is empirically validated in the context of some firms and industries even if the data exhibited $V(Y) > V(S)$ Similarly, some minor modifications in the assumptions of the model provide an explanation of the Blinder paradox To an extent even the Blinder model can be viewed as a production smoothing (optimization) model with the major difference being the optimization on S as well

(c) Almost all the other theoretical arguments offer sufficient conditions for the explanation of the Blinder paradox They are complementary even if they are mutually exclusive As such all of them can be synthesized in the framework of Blinder model

There is a shift of emphasis in the more recent literature Observe that the basic hypotheses summarized in this chapter emphasized only the physical dimensions of the inventory, the costs associated with such policies and so on The tradition has been the assumption that the financial arrangements, though they are important in the implementation of any inventory policy, do not have any bearing on such decisions per

se In other words, capital and financial markets are assumed to be competitive (perfect) However, in practice, capital markets are almost always imperfect The quantitative constraints on the availability of finances to satisfy the working capital requirements do alter the production inventory decisions See, for instance, Kuznets (1964), Milne (1991), Freidman and Kuttner (1993), Carpenter et al (1994), Gertler and Gilchrist (1994), Kashyap et al (1994), Christiano et al (1996), and Guariglia and Schiantarelli (1998) The present study has the objective of incorporating the financial constraints in the Blinder model and providing yet another sufficient condition for the Blinder paradox As such the details of this aspect will be taken up in the next chapter

CHAPTER 3

Credit Constraints

3 1 The Basic Shift in the Emphasis

The neoclassical theory of the firm assumes that the financial markets are perfect in the sense of Modigliani and Miller (1958) Obtaining adequate finances to undertake the desired inventory investment is not a problem in such perfect capital markets That is, there are no quantitative financial constraints on the firm given the market determined interest rate Hence, in such markets, the firm finances investments (both fixed and working capital) at the market determined interest rate In general, the firm makes the decisions regarding capital investments, production, and inventories exclusively on the basis of the product market conditions Consequently there is a dichotomy between the real and financial decisions of the firm

In actual practice most of the capital markets are imperfect for a variety of reasons Under such conditions, as Gurley and Shaw (1960), and Vickers (1968, 1987) noted, there will be a significant interaction between the real and financial decisions of the firm For,
(a) internal finances (based on the cashflow of the firm) are less expensive than external sources, (b) the availability and the cost of external finance depends upon the balance

sheet position of the firm,[1] and (c) the credit policies of the central bank influence the financial decisions of the firm See, for example, Kashyap et al (1993, 1994), Carpenter et al (1994), and Bernanke et al (1996) Hence, the impact of financial arrangements and the constraints they place on the inventory investments should be examined in detail

Analytical studies, such as Calomiris and Hubbard (1990), Bernanke and Gertler (1995), and Hubbard (1998) identified the interest rate, bank credit, and the firm's balance sheet as the primary channels through which capital market imperfections are transmitted to inventory decisions These three channels can be described as follows (a) A decrease in money supply, induced by the central bank, increases the interest rate and influences spending on inventory investment Kuznets (1964, p 335 and p 336), and Callen et al (1990) documented the existence of the interest rate effect (b) The credit channel through which financial decisions affect the real side of the firm's decision process can be stated in the following manner When the capital markets are imperfect the lenders do not have complete information on the borrower's characteristics As a result the lenders increase the interest rates and/or restrict credit made available to some borrowers This, in its turn, affects the real side of the firm's decision process (in particular, capital investments, production, and inventory levels) See, for instance, Calomiris and Hubbard (1990, p 90), Kashyap et al (1993, p 78), Kashyap et al (1994, p 556), Bernanke and Gertler (1995, p 28 and 34), Chirinko and Schaller (1995, p 528), and Kadapakkam et al (1998, p 294) (c) As Guariglia and Schiantarelli (1998, p 67), and Bernanke and Gertler (1995, p 36)

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[1] As noted in Bernanke and Gertler (1995, p 36), and Guariglia and Schiantarelli (1998, p 97) access to external finances may become less expensive and easier when the balance sheet conditions improve in the upturn of the business cycle

pointed out, the ability of firms to finance inventory investments (along with other aspects) depends on the balance sheet positions if the capital markets are imperfect

The following question is the most important from the viewpoint of the present study To what extent are the available finances to the firm irretrievably committed to either long term capital formation or working capital requirements?[2] In other words, how rigid is the decision making process and how low are the costs of making short term adjustments (either in production or in sales) based on the liquidity constraints as they emerge? Carpenter et al (1994), and Fazzari and Peterson (1993) emphasized this point In general they suggest that inventories bear the brunt of the adjustment since they have relatively low adjustment and liquidation costs Also see Kuznets (1964), Hoshi et al (1991), Freidman and Kuttner (1993), and Kashyap et al (1993, 1994)

The presents study is an attempt to examine the financial constraints and their effect on inventory investment within the Blinder model framework The basic channel of transmission of the financial constraints can be stated as follows To begin with assume that there are no financial constraints Then, the firm chooses Y and S optimally and makes arrangements for working capital finance If, for some reason, the firm experiences credit constraints (anticipated or otherwise) the burden of adjustment may be

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[2] Usually the analysis is conducted from the following perspectives (a) Examining the asset structure of the firm to determine its strength so that it has an adequate capacity to borrow from the banks, the commercial paper market, and the term lending institutions Among others Calomiris et al (1990, p 43), and Bernanke et al (1996, p 22) emphasized this aspect (b) The effect of recessionary conditions in the product market on the collaterizable value of the firm's assets (c) To what extent are the credit constraints imposed by the central bank independent of the product market conditions and the asset structure of the firm? The details of the analysis are not relevant to the main theme of the present study They will be pursued where they are relevant

either on Y or S In general, the firm's choices depend on the ex post flexibility of production and the losses associated with not conducting sales as the demand arises The present study maintains that production is flexible ex post On the other hand, adjustments in sales are expensive Hence, the firms can be expected to keep S at a stable planned level and make suitable adjustments in Y if there is a credit constraint The analytical details will be presented sequentially in the rest of the chapter

3 2 The Balance Sheet Identity

The balance sheet identity provides a convenient analytical tool to synthesize the effects of credit constraints on inventory investment See, for example, Hay and Louri (1994, p 162), and Carpenter et al (1994, p 108 and p 117) To begin with, define

Net Trade Credit = Sundry Debtors - Sundry Creditors

Net Fixed Assets = Gross Capital Stock - Accumulated Depreciation

Liquid Assets = Cash on hand + Bank Balances (or, more generally, Reserves and Surpluses), and

Short Term Debt = Bank Borrowings + Other Commercial Borrowings

Then the balance sheet identity can be written as

Inventories + Net Trade Credit + Other assets + Net Fixed Assets = Liquid assets + Short Term Debt + Long Term Debt + Equity

Consider the following possibilities (a) Suppose there is a temporary reduction in the market for the goods and services of the firm This affects the Cash flow (defined as

Retained Earnings + Depreciation Provision) [3] However, the firm may be compelled to hold unintended inventories thereby increasing the financial requirement The firm may first resort to commercial borrowings of a short run nature if the asset structure permits it Otherwise it makes an attempt to postpone paying debts or divert cash provisions set aside for tax purposes Chirinko and Schaller (1995), Devereaux and Schiantarelli (1990), Biddle and Martin (1985), and Gentry and Lee (1986) outlined some of these details They will reduce capital investments and divert long term sources of finance for working capital purposes only as a last resort If the situation persists, some long run adjustments in the inventory investments will be undertaken [4] In practical terms adjustments in the production level become mandatory only if the firm cannot find alternative sources to finance inventory investment (b) In case the recessionary trend continues for a longer time period the possibility of a reduction in the collateral value of the firm's assets can arise See, for instance, Calomiris et al (1990, p 91), and Whited (1992, p 1420) Then, both the amount and terms of borrowing will be against the firm If the firm is able to postpone some of its long run capital investments and release some finances for working capital then the level of inventories may not decrease Clearly, whether such a decision will be made or not depends upon market expectations in the short run as well as the long run (c) Consider the possibility that there is a reduction in bank credit for working capital finances indicated purely by the policy of the central bank in its attempts to control inflation Even in this case inventory investment will be affected only if adjustments cannot be made in other balance sheet items See, for example, Carpenter et al (1994,

[3] See, for instance, Hay and Morris (1981, p 379)

[4] Two points should be recorded (a) Kashyap et al (1993, p 92), and Christiano et al (1996) noted that there will be time lags in this adjustment (b) Carpenter et al (1994, p 86) noted that level and speed of adjustment will depend upon the initial stock of inventory

p 83), and Christino et al (1996, p 16 ff) Thus, the nature of adjustments in both the long term and the short run policies of the firm eventually determine the quantum of inventory investment when the firm is confronted with financial constraints [5]

3 3 The Blinder Model Variant

The Blinder (1982)[6] model provides a more synthetic framework for analysis For, the balance sheet constraint can be readily appended to the basic model to examine the effects of liquidity constraints on the production inventory decisions

Observe that in the short run the firm maintains an optimal ratio of current assets to current liabilities and finances the long term component of the working capital through long term sources of finance Let

I = Inventories

A = Other Current Assets plus Net Trade Credit

B = Bank Borrowings

L = Liquid Assets plus Other Commercial Borrowings

If α is the optimal current ratio[7] the accounting identity can be written as

[5] Some studies examine investments in fixed capital and inventories simultaneously A few of them consider financial policies explicitly See, for example, Feichtinger and Hartl (1985), Fazzari et al (1988), Deveroux and Schiantarelli (1990), Hoshi et al (1991), Milne (1991), Fazzari and Peterson (1993), and Bond and Meghir (1994)

[6] Blinder (1987), and Bernanke and Blinder (1988, 1992) explicitly considered the effect of financial markets on inventory investment though not in the framework of an optimization model

[7] In general the firm maintains an optimal current ratio α which is approximately 2 It depends on the balance between the cost of financing inventories and the expected market value of current assets that will be utilized to redeem short run debt in case the need arises Slow moving inventories, because they are not liquid in short run, must be financed by long term sources

$I + A = \alpha (B + L)$

$\quad = B + X^*$

Where X^* is the exogenously determined long term financing plus short term sources of finance

Then, following Vickers (1968, 1987), and Akhtar (1983) the interest payment component of the cost must be added to the production and inventory cost Similarly, if there is an exogenously determined limit on bank credit, then

$I + X \leq M$

Where

$X = A - X^*$ and,

M = maximum amount of credit available

Vickers (1968, pp 135 ff) initially acknowledged this and formulated the decision making process of the firm taking such a constraint into account The Blinder model can now be written as

$$Max \int_0^\infty e^{-rt}[R(S) - C(Y) - r_b(I + X) - f(I)]dt$$

subject to

$dI / dt = Y - S$ and

$I + X \leq M$

Where r_b is the rate of interest on bank credit [8]

To examine the optimal choices (Y and S) of the firm construct the Hamiltonion

[8] In general it will be expected that $r_b = r_b(I+X)$, $r_{b_x} > 0$ However, the simpler version will be utilized throughout because the results will not be altered fundamentally

$$H = e^{-rt}[R(S) - C(Y) - r_b(I + X) - f(I)] + \lambda(Y - S) + \tau(M - I - X)$$

τ can be interpreted as the profit generating potential of a unit of bank credit

To begin with assume that $r_b = 0$ so that the effect of financial constraints can be isolated explicitly In such a case observe that if there is no limit on working capital investment the firm will choose the desired level of inventory as in the Blinder model Let M* be the bank credit requirements The inventory holding by the firm will be smaller if there is a constraint on the bank credit That is,

$\tau > 0$ for $M \leq M^*$

$\tau = 0$ for $M > M^*$

The pertinent case for analysis is $M \leq M^*$ Given the balance sheet identity it may appear that both I and X will be adjusted for a given M^* However, X is fixed apriori and cannot be altered at short notice even if enough credit is not available to finance the desired inventory investment Only Y and S are the optimal choices of the firm in such a case The optimality conditions can be written as[9]

$$\frac{d\lambda}{dt} = e^{-rt} f_1(I) + \tau \text{ and}$$

$$\lambda e^{rt} = C_1(Y) = R_1(S)$$

It is clear from the $\partial\lambda/\partial t$ equation that the changes in λ as M increases towards M* depends on the variations in τ

[9] Since the credit constraint is binding it will be expected that $\tau > 0$ However, in the spirit of Kahn-Tucker condition, $\tau\ (M - I - X)$ does not contribute to the maximum value of H

Given the nature of the definition of M^* the firm has unfulfilled profitable opportunities of increasing inventories for any value of $M<M^*$ Hence, the present discounted value of profits that can be generated from the extra unit of bank credit will increase with M That is,

$$\frac{\partial \tau}{\partial M} > 0$$

Consequently it can be inferred that $\partial\lambda/\partial M>0$ since τ appears with a positive sign in the $d\lambda/dt$ equation

The optimal response of the firm, in its choices of Y and S, can be deduced as follows

Consider the equation

$$C_1(Y) = \lambda e^{rt}$$

From this it follows that

$$\frac{\partial Y}{\partial M} = \frac{1}{C_{11}} e^{rt} \frac{\partial \lambda}{\partial M} > 0$$

if there are increasing marginal costs of production That is, the firm reduces output when the bank credit is stringent and increases it when credit is available On the other hand, the choice of S is such that

$$\lambda e^{rt} = R_1(S)$$

so that

$$\frac{\partial S}{\partial M} = \frac{1}{R_{11}} e^{rt} \frac{\partial \lambda}{\partial M} < 0$$

In other words, with a greater availability of bank credit the firm prefers to postpone sales

and obtain the larger expected future profits from its inventory holding[10] When the bank credit restrictions are severe, the firm will be forced to sell larger output even if there is a reduction in profits These results have been noted in Guariglia and Schiantarelli (1988), Kashyap et al (1993, 1994), and Carpenter et al (1994)

The above arguments also indicate that the existence of financial constraints makes production more volatile than sales

For,

$$\frac{\partial Y}{\partial M} - \frac{\partial S}{\partial M} = e^{rt} \frac{\partial Y}{\partial M}\left(\frac{1}{C_{11}} - \frac{1}{R_{11}}\right) > 0$$

That is, the existence of financial constraints on working capital adds to the possibility of resolving the Blinder paradox

The effect of r_b on the ex post value of λ can be traced as follows To begin with note that $(d\lambda/dt)e^{rt}$ decreases as I increases due to the increasing marginal cost of inventory holding To arrive at the optimal level of inventory holding the firm compares the discounted present value of the expected returns with the marginal costs Hence, the

[10] Observe that

$R_1(S) = p(S)(1 - \frac{1}{\eta})$ where p(S) is the price per unit of S and η is the elasticity of demand Hence,

$R_{11}(S) = \frac{p(S)}{S\eta}\left(1 - \frac{1}{\eta}\right)$ which tends to large negative values as η tends to zero This suggests that S will be invariant with respect to changes in M when the elasticity of demand is rather low

equilibrium value of I is at the point E in Fig 4 Suppose, there is an ex ante increase in r_b It will imply that the discounted present value of profits expected from a unit of inventory holding will decrease That is, the ex ante value of $(d\lambda/dt)e^{rt}$ will fall as r_b increases The equilibrium level of inventory decreases However, since the firm is generally operating under conditions of monopolistic competition in the product markets, some part of the increase but not the entire amount, can be transferred to the consumer It follows that the reduction in $(d\lambda/dt)e^{rt}$ will be proportionately less than that in r_b That is, as Blinder (1982, p 335) pointed out, the resulting equilibrium value of λ will be larger whenever the products of the firm are difficult to inventory From an intuitive point of view this result implies that with increasing costs of inventory the lower equilibrium value of inventory investment is a result of the necessity to ensure a higher return commensurate with the cost Suppose, however that a lower interest rate is the result of an increase in bank credit Then, there is a simultaneous increase in τ and a reduction in r_b Assume that the firms operate in a fairly competitive product market so that the expected profitability of a unit increase in bank credit, through the corresponding increase in inventory holding , is close to $r_b e^{-rt}$ Then, from the optimality condition

$$\frac{d\lambda}{dt} = e^{-rt}\left[f_1(I) + r_b\right] + \tau$$

it follows that the interest rate effect will be negligible in the presence of a credit constraint

Further, despite the existence of a constraint, most of the firms may be utilizing bank credit as the major source of financing inventories In such a situation the banks do not experience any significant information asymmetry with respect to different borrowers

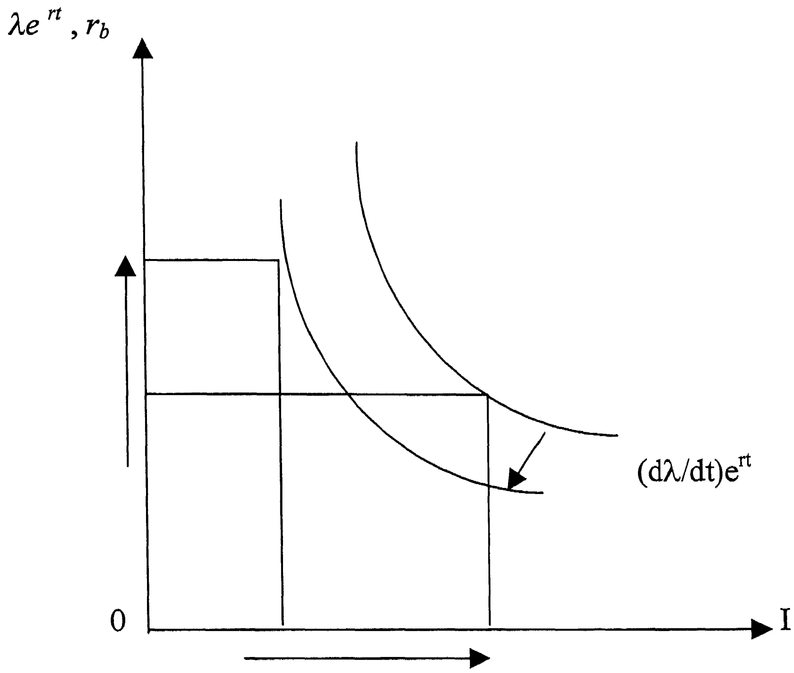

Fig 4 The effect of r_b on the ex post value of λ

Consequently, they will be charging a common market determined, interest rate from all of them Clearly, such a configuration would suggest that the increase in $r_b e^{-rt}$ would be exactly neutralized by the fall in τ To a large extent this appears to be the reason for the observed insensitivity of inventory investment to the changes in the interest rates

Consider the possibility that some firms are predominantly utilizing internal resources to finance inventory In such a case the banks experience an information problem in assessing the collateral value of the firm's assets and its reputation with respect to repayment The banks may then charge a higher interest rate A credit constraint may result in a substantial reduction in the inventory investment Similar is the case with small firms with a low collateral value for their assets and ability to convince the banking system that they are reliable borrowers The effect of the credit constraint will be dominant if it results in a greater reduction in τ in comparison to the increase in r_b only if the adjustments cannot be made in the other balance sheet items See, for example, Carpenter et al (1994, pp 83 ff) and Christiano et al (1996, pp 16 ff) Thus, the nature of adjustments in both the long term and short run policies of the firm eventually determines the nature of inventory investment when the firm is confronted with financial constraints

The following observations will simplify the analysis of the financial constraints while preserving the essential dimensions of the analysis (a) In many practically relevant situations the central bank expects firms to finance the long run component of working capital from long run sources However, for most of the firms, the internal sources of finance, including retained earnings and depreciation provisions - are a small portion of

total requirements [11] In other words, their dependence on bank credit is significant (b) The product markets are generally ologopolistic or monopolistic competition Hence, the firms must utilize, on a priority basis, any long run investment opportunities that they can identify In general, it would be unrealistic to expect them to forgo such opportunities and divert long term finances to working capital This aspect was noted in Fazzari and Peterson (1993, p 329), and Bond and Meghir (1994) [12] Except for a few overlaps the long run decisions with respect to capital formation and its financing are independent of the short run working capital choices and methods of finance

3 4 Some Essential Observations

The extension of the Blinder model, incorporating the credit constraints, provides a fairly general approach to study the inventory decisions and the Blinder paradox As a result the

[11] As Carpenter et al (1994, p 84) noted, " A large fraction of firm's labor and capital costs are fixed or quasi-fixed in the short run With high fixed costs, relatively small movements in revenue can cause large proportional changes in internal finance, particularly since the cash flow is such a small fraction of sales for a typical firm "

[12] Fazzari and Peterson (1993) argued that the firm does not postpone capital investments due to the danger of decreasing their value by delaying them Similarly, Kadapakkam et al (1988, p 317), and Angelini et al (1995) contend that small firms cannot postpone capital investments for the fear of being forced out of the competitive product markets From a practical viewpoint there can be several institutional and structural rigidities which prevent the firm from canceling orders for machinery and equipment even if they are confronted with a short term credit crunch Fazzari and Peterson (1993) go one step ahead They argue that when the investment opportunities are good the firm may divert short run working capital to finance long term capital This is unlikely, especially in the Indian context, since such refinancing (or rolling over) of short term finances for long term capital formation are strictly monitored It should also be recognized that the profit generating potential of a unit of short term finances may be larger if they are used to increase current production with the existing capital stock The present discounted value of profit potential if these finances are channeled to long term capital may indeed be lower To a large extent the use of funds in one or other directions also depend on the time horizon over which the firm plans If the firms are myopic and try to generate profits from the existing capital as soon as possible the preference will be to augment current production

basic hypothesis of the present study can be viewed only as an empirical regularity embedded in the model [13] The following observations are pertinent in this context

(a) More often than not there will be positive levels of inventory holding in the context of firms in monopolistic competition since the goodwill costs of not satisfying demand can be quite high Hence, f(I) may not have the backlogging cost interpretation which Blinder incorporates in his model Instead f(I) generally captures all these aspects and not merely the cost of holding inventory [14]

(b) In chapter 1 it was pointed out that most of the firms in monopolistic competition choose a relatively stable level of sales While the model of the present chapter allows this possibility it cannot be claimed as a unique theoretical conclusion The sensitivity of S_t to demand shocks, cost shocks, and credit constraints can be determined only on an empirical basis

The empirical implications of this generalization of the Blinder model presented in this chapter will be the basic theme of the rest of the study

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[13] As with the basic Blinder model, this generalization also allows the possibility that V(Y) < V(S) On the other hand, the basic proposition of Chapter 1 was that V(S) is not influenced by credit constraints whereas V(Y) is Hence, V(Y) > V(S) whenever Y is affected by the credit conditions Perforce this will remain one of the general solutions of the Blinder model Specifying rigid theoretical conditions to get his result from the model will be counter productive since all firms and all industries do not show greater volatility of production relative to sales

[14] The qualitative differences between backlogging costs, goodwill costs, and inventory costs are quite clear However, the quantitative specification in an algebraic form does not provide a means of making the subtle distinctions

CHAPTER 4

Specification of Variables

4 1 The Sources of Data

The study is based on a time series data for the period 1964-65 to 1994-95 for 15 industry groups [1,2] The analysis has been restricted to those industries for which relevant and consistent data was available No particular sampling technique has been employed

The data set consists of the Combined Income, Value of Production, Expenditure and Appropriation Accounts and Combined Balance Sheet published by the Reserve Bank of India in the RBI bulletin For the time period 1965-1979, the data was available directly from the RBI bulletin After these years the bulletin's coverage was reduced and published information was highly truncated The statistics for the remaining years was therefore procured from the Department of Statistical Analysis and Computer Services, Mumbai [3]

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[1] The empirical analysis in this chapter attempts to explore the relevance, in the context of various industry groups, of the diverse theoretical viewpoints, presented in chapters 2 and 3, regarding the Blinder paradox

[2] There are several databases for conducting such an analysis Prominent among them is the firm level data from the Bombay stock exchange directory, and the CMIE data The former is very extensive but a consistent time series is not available on computer tapes and CD-ROM's As such it is impractical for any one researcher to use such data The CMIE time series is too short and the data is not being published in recent years Hence, the study is restricted to industry level data This database provides an opportunity to examine the differences across industries more prominently compared to the firm level data

[3] The RBI bulletin is also published from DESACS For that reason the original source of data was same in both the cases and hence both the series were comparable

The following industries have been considered for the empirical analysis

1 Tea Plantations

2 Sugar

3 Cotton Textiles (spinning, weaving, composite mills and others)

4 Jute Textiles

5 Automobiles (vehicles, components, repairs etc)

6 Electrical Machinery (cables, dry cells, electric lamps, other electrical machinery, apparatus and appliances)

7 Aluminum and other Ferrous/ Non-Ferrous Metal Products

8 Chemical Fertilizers (including dyes and dye stuffs, man made fibers, plastic raw materials, and other basic industrial chemicals)

9 Medicines and Pharmaceutical Preparations

10 Paints and Varnishes (other allied products, and other chemical products)

11 Cement (hydraulic, asbestos, and asbestos cement products)

12 Potteries (structural clay products, pottery china and earthenware (ceramics))

13 Tyres and Tubes (and other rubber products)

14 Paper and Paperboard (including products of pulp)

15 Electricity Generation (and supply)

Macro level data, for the Net National Product (NNP), was taken directly from the National Income Statistics published by the Central Statistical Organization

The number of firms for each ındustry group was not exactly the same for every year of the tıme serıes Hence, to make the figures comparable, the data was reduced to per firm level [4]

In the per firm data set so produced ıt was notıced that there were outlıers ın the tıme serıes In partıcular, the data for years 1974-75, 1978-79, and 1979-80 were dıfferıng sıgnıficantly from the rest of the serıes For these years the number of firms provıdıng the data was eıther very small or very large To avoıd errors ın calculatıons because of these aberratıons, the data for the correspondıng years was elımınated from the analysıs

Although the figures were avaılable for a wıder range of ındustrıes all of them could not be taken ınto consıderatıon Some of the ındustrıes had to be dıscarded because the data was not obtaınable for all the years For the other ındustrıes the number of firms was very small

4 2 The Varıables

The Value of Productıon and Net Sales were the dependent varıables ın the regressıon analysıs These were obtaıned dırectly from the data set

The ındependent varıables were as follows

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[4] Clearly there ıs no guarantee that the coverage of firms does not change from one year to the next Gıven the heterogeneous and multı-product structure of many of the firms ın any gıven ındustry group even the comparabılıty of per firm data ıs only notıonal To that extent the present study ıs experımental rather than beıng conclusıve

(1) Gross Fixed Assets It was obtained directly from the data set

(2) Average Cost = (Raw Materials and Components consumed + Stores and Spares + Power and Fuel + Other Manufacturing Expenses + Salaries and Wages + Depreciation) / Value of Production

Several components of costs were calculated These included

(3) Raw materials and Components consumed / Value of Production

(4) Stores and Spares / Value of Production

(5) Power and Fuel / Value of Production

(6) Other Manufacturing Expenses / Value of Production

(7) Salaries, Wages and Bonus / Value of Production

The financial variables included in the analysis were

(8) Cash flow = Depreciation Provision + Retained Profit[5]

(9) Bank Borrowings This was obtained directly from the data set

Shocks for most of the variables were calculated to capture the effects of unanticipated changes The following variables were included in the regression

(10) Demand Shock The trend in Net Sales was calculated using *NNP*

$$ln\ NS = a + b\ ln\ NNP$$

$$ln\ NS\dagger = a\dagger + b\dagger\ ln\ NNP$$

$$SNS = [\ (NS - NS\dagger)\ /\ NS\dagger] * 100$$

Where $a\dagger$, $b\dagger$, $NS\dagger$ were the estimated values from the regression

(11) Cost Shocks The trend for Cost Shocks was calculated through a regression against the log value of the Value of Production

[5] See, for instance, the description of Cash Flow in Hay and Morris (1991, p 379)

$\ln AC = a + b \ln VP$

$\ln AC\dagger = a\dagger + b\dagger \ln VP$

$SAC = [(AC - AC\dagger)/ AC\dagger] * 100$

The shocks for the various cost components were calculated on a similar basis

(12) Shocks in Bank Borrowings First a regression was done using log values of *BB* verses the log of time and a trend was calculated Shocks were then calculated on the basis of deviations from the trend values

$\ln BB = a + \ln t$

$\ln BB\dagger = a\dagger + b\dagger \ln t$

$SBB = [(BB - BB\dagger) / BB\dagger] * 100$

Since the present study is based on a time series data it was necessary to examine the presence of unit roots The Dickey Fuller test revealed that most of the variables exhibit one unit root Lag values for all the variables were therefore introduced in the analysis

A perusal of the tabulated data series indicated three significant structural breaks over time Roughly, they correspond to the years 1974-75 to 1979-80, 1980-81 to 1989-90, and 1990-91 to 1994-95 The first two time periods perhaps reflect the oil prices shocks resulting from the formation and decision making of the OPEC The last phase represents the effect of liberalization of the economy It was necessary to incorporate these structural breaks in the analysis Hence, dummy variables d_1, d_2, d_3 were created such that

For years 1974-75 to 1979-80 $d_1 = 1$ otherwise $d_1 = 0$

For years 1980-81 to 1989-90 $d_2 = 1$ otherwise $d_2 = 0$

For years 1990-91 to 1994-95 $d_3 = 1$ otherwise $d_3 = 0$

For all practical purposes these are the proxy variables for the theoretically defined sources of variation

4 3 Expected Signs

Economic theory provides information regarding the effects of each of these variables on the production and sales decisions of the firms They will be outlined in this section to provide guidelines for the empirical analysis detailed in chapter 5

(1) Gross Fixed Assets When the firm is large there are significant fixed costs Further, the average cost of production can be kept low only if the firm produces an output at or close to the capacity level This aspect must be combined with the need to satisfy the demand as it arises Under monopolistic competition non-price decisions (like selling costs) can be utilized to create demand for the products of the firm instead of passively reacting to the exogenously given demand Both of these aspects suggest that larger firms tend to target a greater capacity utilization rate Hence, it should be expected that *GFA* will have a positive sign in the *VP* equation

(2) Average Cost The observed changes in the average cost reflect either a movement along the average cost curve as the output varies or a shift in the cost curve for any given

level of output In the first case, given that firms in monopolistic competition operate below the capacity level output most of the time, an increase in average cost is a consequence of the increase in output and not a cause However, the negative correlation may appear in the regression though no causation can be attributed to it In the second case, a ceteris paribus shift in the average cost curves reduces the profitability of the firm for a given demand Hence, the output is reduced Therefore, a negative sign on AC is expected in the VP equation in either case If the cost increases cannot be transferred entirely to the consumer there is a possibility that net sales will also decrease

(3) Cash flow An increase in the internal Cash flow can be considered as equivalent to relaxing the credit constraint of the firm The theoretical argument of chapter 3 then suggests that production will be enhanced Thus the variable has a positive sign in the production equation Economic theory also indicates that there can be a reduction in net sales However, this reaction is contingent upon the importance which the firm attaches to maintaining the sales level and/or market share As outlined in Chapter 1 the hypothesis of the present study is that such financial variables have no effect on the decision pertaining to net sales

(4) Bank Borrowings An increase in the Bank Borrowings has an effect, which is similar to the Cash flow The availability of finances induces the firm to increase the level of production Therefore it has a positive sign in the production equation However, two points must be kept in perspective First, a ceteris paribus increase in the availability of finances cannot, in itself, increase production For, the demand conditions will be the

basic driving force Second, if the industry is chronically financially constrained there is always a possibility that the variations in production over time are different from those in sales In such cases, the positive sign of the financial variables in the production equation reflect the adjustments in the desired level of inventories for a given profile of demand over time

(5) Demand Shocks The basic Blinder model suggests that an increase in Demand Shocks lead to an increase in both production and sales levels though the quantitative magnitude depends upon the expected value of inventory holding Hence, Demand Shocks have a positive sign in both the production and sales equations

(6) Shocks in Average Cost A sudden and unexpected increase in the average cost reduces the level of production partly because the firm is operating in a finance constrained environment Such a reduction is also a result of the reduction in the expected profitability In general, shocks in average cost have a negative relation with the production levels The shock in average cost also leads to a fall in the sales level For, given their preference for retail price maintenance over time firms find that their profit margins are eroded If the Cost Shocks are persisitent the policy of increasing production when costs are low also allows the firms to build inventory and maintain future sales even if they have to reduce production for a certain length of time The shocks in cost components can be expected to behave in a similar manner

(7) Shocks in Bank Borrowings If a reduction in bank credit is expected firms may alter both the production and the sales levels optimally On the other hand, an unanticipated increase in Bank Borrowings manifests itself in the form of an increase in production For, as suggested earlier, changes in sales are much less likely In general firms would build up inventory in an attempt to increase profitability in the future

(8) Lag of Value of Production Suppose the firm increases its level of production in the last time period Some of the reasons for this are

(a) there was an increase in demand or it was expected in some future time period

(b) there was a downward shift in the average cost curve, and / or

(c) there was a relaxation in the finance constraints

The changes in the current level of production depend on these sources as well as other factors pertinent to the current time period In particular, the following aspects should be noted

(a) If the increase in demand for the previous time period was temporary no changes can be expected On the other hand, if it is a result of expectations of increase in future demand the trend may continue

(b) If the increase in output was due to a cost reduction and if the firm finds that adequate inventories have been accumulated then it may reduce production in the current time period On the other hand, if the cost reductions are small and persistent output can have a positive trend

(c) The argument with respect to the effect of the financial constraints is similar In general, it would be difficult to assign any specific sign for this variable in either of the equations

(9) Lag of Net Sales If the sales in the last time period had been high then it can be concluded that the inventory level would be lower than desired in the current time period The production in the present time period will, therefore, be enhanced to bring the inventories back to the desired equilibrium level If the sales for time t-1 was high then the sales for t would also increase because the firm would have managed to build a good market share by time t It can be expected that the new customers it had gained in the previous year would show brand loyalty Moreover, the goodwill of the firm would have increased and this would help in increasing sales Therefore, lag of net sales has a positive sign in both the sales and production equations

(10) Lag in Inventories If the inventory level of the previous time period was high, it would lead to a fall in production in the current time period since the excess inventory would have to be sold out [6] Lag in inventories therefore has a negative sign in the production equation Further, the above argument implies that the lag of inventory variable has a positive sign in the sales equations

[6] There is one basic difficulty in this interpretation For, it can always be stated that the high level of inventory of the previous time period is either because production has gone up or sales level has gone down Two of the three variables can be independent Hence, the possibility of multicollinearity must be kept in perspective while doing the computations

(11) Lag in Demand Shocks If there was an unexpected rise of demand in the previous time period, the firms would have increased sales to a certain extent and drawn down inventories This necessitates an increase in production in the current time period

(12) Lag of Cost Shocks Assume that the firm experienced a cost shock at t-1 Then it would have reduced production and sales during t-1 However, there is a possibility that inventory levels would have been reduced If the firm tries to retain the desired levels in the current time period it can be expected that output will go up It is therefore difficult to assign a definitive sign for this variable in the sales equation However, if the increase in cost shock in t-1 could be passed on to the consumer a positive sign is expected in the sales equation It can be postulated that the components exhibit similar behavior

(13) Lag of Cash flow If there was an increase in the cash flow in the previous time period it may lead to an increase in the production for the current time period whenever there is a time lag in production

(14) Lag of Shocks in Bank Borrowings Suppose there was an unexpected increase in bank credit at t-1 The major effect is an increase in the production level of that time period As with the *LVP* variable it is difficult to assign a specific sign to this variable

On the whole, while economic theory provides adequate guidelines for the effect of the independent variables on the production and inventory decisions of the firms there are difficulties in identifying the extent to which the variables have effects that are

ındependent of the others The empırıcal results presented ın the next chapter wıll be able to resolve some of these ambıguıtıes

CHAPTER 5

Test of the Hypothesis

5 1 The Hypothesis Restated

The basic hypothesis of this study can be stated as follows

(a) The primary stylized fact about inventory decision of firms, as exemplified in the Blinder paradox, is that production is more volatile than sales at both the macro and micro levels

(b) The persistence of demand shocks and cost shocks offer sufficient conditions to explain this stylized fact However, they are not necessary Similarly, it is possible to observe $V(Y)<V(S)$ even in the presence of such shocks This aspect of the Blinder, and Miron and Zeldes explanations kept the search for a more satisfactory explanation alive

(c) The existence of financial constraints on firms operating in imperfect capital markets provides another explanation Under conditions of monopolistic competition it is most likely that the firms prefer to either maintain a constant level of sales or a fixed market share to ensure that their market position is not eroded Under these conditions a financial constraint, whether it is anticipated or not, does not allow the firm much flexibility with respect to the level of sales Perforce, the burden of adjustment falls on the volume of production It should be expected that whereas sales will be

insensitive to financial constraints the level of output will be affected by such constraints in a fundamental manner If this proposition can be verified empirically it provides a much stronger sufficient condition for the persistence of $V(Y)>V(S)$ The empirical work is primarily directed towards a test of this hypothesis

5 2 The Ramey Hypothesis

In Chapter 2, section 2 5, the Ramey hypothesis regarding convex costs is considered as a possible explanation for the greater volatility of production relative to sales However, the final results, which will be reported in section 5 5 below, did not support the hypothesis It is therefore necessary to examine the test of the non-convex cost hypothesis separately

For this purpose the AC curve was estimated as a function of the Value of Production and the square of it Table 1 summarizes the regression results so obtained It can be observed that six industries experience non-convex costs These are (a) Tea Plantations, (b) Jute Textiles, (c) Chemicals and Fertilizers, (d) Cement and Asbestos (e) Paper and Paperboard, and (f) Electricity Generation The results presented in section 5 5 below indicate that it can therefore be expected that these industries adopt the (S,s) type of inventory policies However, four industry groups viz , (a) Jute Textiles, (b) Cement and Asbestos, (c) Paper and Paperboard, and (d) Electricity Generation experience credit constraints In general, such financial constraints do not allow the firms to take

advantage of the non-convexities in costs[1] The case of Tea Plantations is somewhat different It is an agro based industry and therefore planning bulk production in some time periods is not possible The production level depends upon climactic, and geographical factors and the area under cultivation Financial constraints were not important in the context of Chemicals and Fertilizers The cost shocks were dominant in this case The primary reason for this is the oil price increase and the technical changes necessitated by it Partly for this reason the industry also experienced rather large demand shocks Both these factors inhibit the firms from taking advantage of the non-convex costs

In general, there is not much evidence of non-convex costs Even when such an advantage is present there are other compelling forces dominating the production decisions The data set of the present study does not provide any support to the Ramey hypothesis

[1] There is a possibility that annual data utilized in this study mask the prevalence of (S,s) policies over shorter durations In general, the cyclical patters of demand and cost may be exhibited within an year rather than across years Further testing is warranted as and when such detailed data is available

TABLE 1 TEST FOR RAMEY HYPOTHESIS

INDUSTRY	CONS	VP	VP^2	R^2	DW
TEA PLANTATIONS	69299 (11766E-01)		- 16895E-07 (34497E-08)	99554	1 3598
SUGAR	80611 (12763E-01)			99427	81633
COTTON TEXTILES	78648 (15087E-01)			99161	37895
JUTE TEXTILES	84215 (15037E-01)	64780E-04 (14765E-04)	- 10678E-07 (28497E-08)	99918	1 5542
AUTOMOBILE	81833 (11170E-01)			99573	1 8498
ELECTRICAL MACHINARY	78190 (34886E-02)			99954	86829
ALUMINIUM & OTHER METALS	76250 (26980E-01)			97201	1 3157
CHEMICALS & FERTILIZERS	66845 (10259E-01)	42804E-04 (50642E-05)	- 32081E-08 (42522E-09)	99880	1 2166
MEDICINES & PARMACEUTICAL PREPRATIONS	74660 (45229E-01)			92216	1 8593
PAINTS & VARNISHES	75484 (13128E-01)	31296E-05 (29445E-05)		99719	1 7710
CEMENT & ASBESTOS	67617 (34184E-01)	18978E-04 (12494E-04)	- 15369E-08 (76264E-09)	98859	37145
CLAY & POTTERIES	74117 (74763E-02)			99767	58060
TYRES & TUBES	78648 (15087E-01)			99161	37895
PAPER & PAPERBOARD	67279 (17849E-01)	95555E-04 (15953E-04)	- 12204E-07 (24105E-08)	99734	82310
ELECTRICITY GENERATION	74016 (11918E-01)	57992E-05 (13590E-05)	- 89560E-10 (23251E-10)	99774	31943

Note

(1) Numbers in brackets, below the estimated coefficient, are standard errors

(2) R^2 corrected for the degrees of freedom

5 3 Some Preliminary Observations

A perusal of the data indicated that $V(Y)>V(S)$ in 12 out of 15 industries taken up for this study In contrast, it was observed that $V(Y)<V(S)$ in the context of (a) Tea Plantations, (b) Aluminum and other Ferrous/Non-Ferrous Metals, and (c) Paper industry It is therefore necessary to examine the reasons for this result

To begin with note that the argument pertaining to financial constraints holds only in a ceteris paribus context Hence, other influences, like the demand and cost shocks, may negate this result For, the Blinder model and its extentions do not rule out the possibility that $V(Y)< V(S)$ To systematize the argument formally recall that the variations in Y and S are a result of the observed changes in (a) demand shocks, (b) cost shocks, and (c) the credit constraints Positive demand shocks tend to increase both Y and S The effect of positive cost shocks depend on the pricing policy of the firm Suppose the firm adopts a retail price maintenance strategy Then, with a cost increase the profit margins are eroded and both the sales levels and consequently the volume of production are affected On the other hand, if the firms can pass on the costs to the consumer, though not entirely, then the effect on the volume of production will be greater than that in sales In general, the demand shocks have a greater effect on sales and the cost shocks and credit shocks affect production volumes disproportionately Hence, if demand shocks are dominant it can be

expected that $V(Y)<V(S)$ is still possible On the other hand, $V(Y)>V(S)$ will be observed if demand shocks are not significant

With this background in perspective consider the three industries for which $V(Y)<V(S)$ was recorded

In the case of Tea Plantations three factors appear to explain the observed result (a) This industry experienced significant cost shocks [2] Despite this the price of tea remained more or less stable over the years That is, due to the significant elasticity of demand the firms are not in a position to pass on the increase in costs to the consumers (b) In the absence of price flexibility in the domestic market the firms attempt to explore the international market Significant changes in prices and total demand were recorded only occasionally (c) Tea Plantations is an agriculture based industry Consequently the production level cannot be altered significantly from one time period to the next The effects of the cost and credit constraint are dominant

The volatility of sales is higher than that of production in the context of the primary metal based industry as well Primary metals experienced significant changes in cost internationally Hence, the shocks in cost components influenced the production levels in a fundamental way The demand shocks are the primary factor determining the sales The market for these goods is highly competitive though growing steadily As such the demand cannot be forgone The high goodwill cost in these markets accounts for $V(Y)<V(S)$

The third industry group in this category is Paper and Paperboard This industry has experienced significant expansion in the variety of uses and hence products It also experienced large cost changes due to technological advancement The resultant cost shocks were the primary force behind the increase in demand and sales This industry has a relatively low level of technological sophistication and requires a low level of investment for firms to enter the market This keeps the market competitive Firms need to plan a steady level of capacity utilization to minimize goodwill costs However, they are subject to large changes in sales due to cost shocks

In general the net effect of these variables would be adequate to explain the net effect on the variability in production and sales

5 4 The Estimation Method

The theoretical versions of the Blinder model, elaborated in Chapters 2 and 3, indicate that the basic decisions of the firm are the level of production and the volume of sales[3]

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[2] Corroborative empirical evidence will also be presented in section 5 5

[3] It is entirely possible that in the actual managerial decision process the inventory decision is primary and the production level choice is a consequence For, the marketing manager may set a sales target first Based on his/her experience the production manager may find it necessary to maintain a certain level of inventory to make sure that the sales target can be fulfilled Since these variables are related through an identity the results will not be different irrespective of which two decisions are considered to be primary

[4] AC was included in this specification to obtain a test of Ramey hypothesis regarding the non-convexity of costs However, it is evident from the analysis of the previous chapter that this test is not conclusive

Based on the theoretical structure of the modeling framework the independent variables in the production equation are *GFA, AC, BB, CF, IR, SNS, SAC, SRVP, SSP, SPF, SOM, SSW, SCF, SBB*, d_1, d_2, d_3 and the lags of the corresponding variables[4]

The independent variables included in the sales equation are *NNP, AC, CF, BB, SNS, SAC, SRVP, SSP, SPF, SOM, SSW, SCF, SBB*, d_1, d_2, d_3 and the relevant lag variables

At the outset both the *VP* and *NS* equations were estimated separately The computational procedure was designed to check the relevance of each variable and also possible combinations of the variables specified in the model A variable is retained whenever the t value associated with it exceeds unity because, as is well known, the contribution to R^2 (corrected for degrees of freedom) will then be positive The best result, based on R^2 and t value for each of these variables included in the equation, was selected The Blinder framework considers the production and sales choices of the firm as joint decisions and hence estimating the equations separately is not sufficient Instead, the two equation model has the structure of Zellner's SURE Hence, the SURE procedure was utilized to improve the efficiency of the estimated equations

[4] AC was included in this specification to obtain a test of Ramey hypothesis regarding the non-convexity of costs However, it is evident from the analysis of the previous chapter that this test is not conclusive because the reverse causation is more likely

5 5 Empirical Results

This section analyzes the empirical findings systematized in Table 2, and Tables 3 (a) and 3 (b) The regression results for each of the 15 industry groups is presented in Table 2 The frequency of occurrence of each variable in the production and sales equation is detailed in Tables 3 (a) and (b) [5]

The results presented in Table 2 and Tables 3 (a) and 3 (b) provide overwhelming support for the view that in monopolistic competition the firms do not adjust sales in response to financial constraints Instead, most of the adjustment is in the level of production. Hence, ceteris paribus the presence of capital market imperfection and financial constraints account for the greater volatility of production

Observe that the Gross Fixed Assets variable appeared in 13 out of the 15 industry groups This indicates that most of the firms, due to their large fixed costs, target a specific level of capacity utilization and stabilize sales at that level by suitable non-price strategies Clearly, production smoothing of a basic nature is indicated That is, if there are no financial constraints and cost shocks then the firm will smooth production This reinforces the crucial importance of financial constraints in explaining $V(Y)>V(S)$

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[5] One potential criticism of the presentation may be that the economic implication of the occurrence of lag variables have not been stated in detail Recall that the lag values had to be included in the analysis due to the presence of unit roots They do not have any significant role in the theoretical or the empirical explanation of the model

The demand and cost shocks have similar affects on the production equation On the other hand, demand shocks dominate the sales equation However, the fact that $V(Y) > V(S)$ in most of the industries suggest that the cost shocks are the more potent explanation for the observed volatility of production

In an attempt to identify the role of the different exogenous variables in various industry groups the sample has been segmented into six industry types They are

(a) Agro based industries – Tea Plantations, Sugar, and Paper and Paperboard

(b) Primary material based – Aluminum and other Ferrous/Non-ferrous Metals, Cement, Clay and Potteries, and Tyres and Tubes

(c) Textiles – Cotton Textiles and Jute Textiles

(d) Automobiles

(e) Chemicals – Chemical Fertilizers, Medicines and Pharmaceuticals, and Paints and Varnishes

(f) Electrical – Electrical Machinery, and Electricity Generation

Among the industries in the agro based segment, the behavior of Tea Plantations and Paper and Paperboard has already been discussed in Section 5 3 The sugar industry behaves differently Three specific reasons for this can be identified

(a) The price of sugar has been fluctuating over the years This implies that the shock in the cost component(SWSV) has been passed on to the consumers

(b) The effect of demand shock on sales is minimized because of the existence of credit constraint in the form of BB

(c) Sugar is a homogenous product in the market Consequently the goodwill cost in the sugar industry is not very high On that account the firms do not need to cater to the entire amount of increase in demand The financial constraints dominate the decision making in this industry [6]

Consider the primary material based industries For three out of the four industries in this category the variance of production is greater than that of sales The results obtained in Table 2 for Cement and Asbestos, Clay and Potteries, and Tyres and Tubes differ from that of Aluminum and other Ferrous/non-Ferrous Metal products primarily due to two reasons Firstly, these industries face credit constraints Moreover, as already noted, the price fluctuations have been especially high, shocks in cost components do affect the sales level but their influence is overshadowed by the credit constraints and their effect on production The second explanation for the higher production volatility in these three industries is the Gross Fixed Asset formation The market in these industries has been growing Therefore the firms anticipate higher demand On that account the firms make capacity adjustments in order to meet the production requirements Concurrently, firms may hold a desired level of inventory commensurate with the anticipated demand since production adjustment at short notice can be expensive The existence of such a desired level of inventory generally explains $V(Y)>V(S)$

[6] The seasonal nature of industry may suggest that non-convexity of costs may be important However, the empirical evidence does not support this probably because the data is on yearly basis

The third category of industry includes Jute Textiles and Cotton Textiles Shocks in cost components and the credit constraints are the most important explanatory variables for this group A number of firms in this category have been reported to be experiencing losses This has caused a decrease in the internal cashflow and a low collaterizable value of their assets In turn this has made the external sources of finance also difficult The cost shocks have been mainly in the form of costs in Other Manufacturing Expenses and Power and Fuel The prices of Power and Fuel have been fluctuating and they have an important impact for the Cotton Textile industry

Consider the Automobile Industry Proponents of the Ramey hypothesis would argue the existence of an (S,s) inventory policy for the automobile industry because of advantages of bulk production in this sector The industry is however facing credit constraints and the possibility of production adjustments of this nature is not observed in practice Power is an important component in production and fuel is a complementary product The fluctuations in the cost of Power and Fuel therefore cause production volatility

Turning to Chemicals it is seen that the Gross Fixed Assets is the most significant explanatory variable in this segment of industries The empirical results suggest that the firms here operate at or close to capacity levels and face demand changes Since the market for Chemical Fertilizers, Medicines and Pharmaceuticals, and Paints and Varnishes have been growing due to technological advancement the firms anticipate a positive trend in the demand conditions They therefore make continuous adjustments in

the production capacity Thus the changes in the production and capacity adjustments exceed the variation in the demand levels

In the Electrical Goods industry group it is noticed that the exogenous factors do not alter the sales level This makes production more volatile in relation to sales

Given these empirical results, the relative importance of various exogenous variables can be studied Refer to Tables 3 (a) and 3 (b), which contain the frequency of occurrence of the variables Consider the production equation first It is seen that *GFA* is the most frequently occurring (in 13 out of 15 industries) variable The firms therefore make capacity adjustments to meet the demand conditions The finance variables, particularly anticipated changes in the credit conditions, have a significant role in the production decisions Shocks in cost components are the next most frequent Of these shocks in Power and Fuel are the most pertinent

Consider next the sales equation The demand shocks and the shocks in cost components influence sales The demand shocks influence sales of those industry groups for which the goodwill costs are very high Cost components affect the sales of those industries which adopt the retail price maintenance policies

TABLE 2 THE ESTIMATED EQUATIONS

1 TEA PLANTATIONS

First Stage Equations[7]

VP = – 5 5338CONS + 3 6255LBB + 3 8323SNS + 29513GFA – 9 1747SPFV

(47 470) (1 5522) (1 9387) (05805) (1 7294)

-1 6264SOMV + 686 62d_2 + 971 25d_3

(47692) (155 31) (249 77)

R^2 = 98876[8] DF = 16

NS = 60 63 CONS + 35261LNS + 889 13d_2 + 1708 0d_3 – 7 7928SPFV – 1 9231SOMV

(86 948) (18413) (235 81) (452 22) (3 2622) (95409)

R^2 = 94321 DF=18

SURE Estimates[9]

VP = 2 6871CONS + 3 7148LBB + 2 8828SNS + 22238GFA – 9 6160SPFV

(43 135) (1 3461) (1 5615) (04717) (1 5109)

-1 7434SOMV + 1158 1d_3 + 753 53d_2

(43627) (219 58) (134 03)

NS = 60 991CONS + 34545LNS + 896 82d_2 + 1724 4d_3 – 7 8724SPFV –1 9302SOMV

(80 705) (17168) (222 86) (424 03) (3 1260) (92848)

R^2 = 97806 R^2M[10] = 97806 F = 126 31 DF FOR F(12, 34) DF FOR T = 34

[7] The numbers in the brackets are standard errors

[8] Corrected for degrees of freedom

[9] See Zellner (1962)

[10] The R^2 is corrected for degrees of freedom For the specification of R^2 M see See McElroy (1977), and Buse (1979)

2 SUGAR INDUSTRY

First Stage Equations

VP = -58 399CONS + 0 6725 LNS +0 4189GFA + 307 48d_2 + 1 5000BB - 0 4848 LINV
(20 648) (04756) (06035) (29 713) (14189) (07633)
+ 6 5779SNS
(1 4148)

R^2 = 99943 DF = 17

NS = 38 971CONS + 57881LNS + 1 9558 LINV – 1 9151 LBB + 257 12d_2
(53 875) (13976) (81020) (1 1825) (72 257)
+ 6 2517SNS - 4 5383 SWSV
(2 3400) (2 9116)

R^2 = 99697 DF = 17

SURE Estimates

VP = -58 516CONS + 67569LNS + 41460GFA + 306 59d_2 + 1 4982BB - 48299LINV
(20 641) (04754) (06031) (29 704) (1 4178) (07630)
+ 6 5807SNS
(1 1414)

NS = 36 471CONS + 58819LNS + 1 8945LINV – 1 8261LBB + 257 99d_2 + 6 2984SNS
(53 850) (13968) (80962) (1 1816) (72 226) (2 3393)
- 4 4471SWSV
(2 9095)

R^2 = 99902 R^2M = 99902 F = 2880 8 DF FOR F = (12, 34) DF FOR T = 34

3 COTTON TEXTILES

First Stage Equations

VP = 339 71CONS + 38707GFA + 3 5175CF + 3 7057BB + 893 67d_2 + 1248 96d_3

(103 60) (15241) (1 0533) (70246) (223 66) (422 62)

-8 7555SPFV

(3 4400)

R^2 = 99794 DF = 17

NS = -161 94CONS + 1 1726LNS

(189 36) (03043)

R^2 = 98540 DF = 22

SURE Estimates

VP = 341 26CONS + 38948GFA + 3 4171CF + 3 7434BB + 891 69d_2 + 1207 6d_3

(93 215) (13102) (90552) (60403) (192 29) (363 31)

-8 0058SPFV

(2 9571)

NS = -147 36CONS + 1 1695LNS

(200 22) (03216)

R^2 = 99591 R^2M = 99591 F = 1357 8 DF FOR F = (7, 39) DF FOR T = 39

4 JUTE TEXTILES

First Stage Equations

$$VP = -1141\ 7CONS + 3\ 8682BB + 4\ 0265GFA + 10\ 725SNS + 5\ 8885LSBB + 169\ 93d_2$$

(79 283) (45793) (31281) (2 1983) (1 3705) (56 268)

$$+1\ 2339LCF - 1\ 2437SOMV$$

(49361) (68317)

$R^2 =\ 99519$ DF = 16

$$NS = 1875\ 4CONS + 35\ 193SNS$$

(259 14) (21 615)

$R^2 =\ 10754$ DF=22

SURE Estimates

$$VP = -1125\ 0CONS + 3\ 8500\ BB + 4\ 0029GFA + 10\ 851SNS + 5\ 8532LSBB +$$

(72 472) (41850) (28587) (2 0131) (1 2525)

$$168\ 71d_2 + 1\ 2267LCF - 1\ 2394SOMV$$

(51 422) (45110) (62434)

$$NS = 1875\ 4CONS + 35\ 193SNS$$

(278 47) (23 227)

$R^2 =\ 99040$ $R^2M =\ 99040$ F = 490 14 DF FOR F = (8, 38) DF FOR T = 38

5 AUTOMOBILES

First Stage Equations

$$VP = 6078\ 9CONS + 1\ 5225GFA + 2\ 7518CF - 7939\ 1AC - 16\ 132SPFV$$

(1987 9) (06586) (44317) (2402 6) (8 4132)

$R^2 = 99457$ DF = 19

$$NS = 320\ 00CONS + 98721LNS + 2279\ 9d_3 + 29\ 123SNS$$

(469 85) (10871) (1184 4) (17 570)

$R^2 = 95115$ DF = 20

SURE Estimates

$$VP = 5908\ 4CONS + 1\ 5280GFA + 2\ 6951CF - 7723\ 4AC - 16\ 145SPFV$$

(1955 4) (06485) (43613) (2363 3) (8 2794)

$$NS = 321\ 97CONS + 99815LNS + 2246\ 0d_3 + 29\ 415SNS$$

(475 31) (10983) (1195 6) (17 749)

$R^2 = 98980$ $R^2M = 98980$ F = 540 44 DF FOR F = (7,39) DF FOR T = 39

6 ELECTRICAL MACHINARY

First Stage Equations

VP = 102 36CONS + 2 3003GFA + 9 4745SNS

(47 089) (03362) (2 8866)

R^2 = 97964 DF = 21

NS = 12 844CONS + 1 0740LNS + 556 62d_3

(117 33) (06497) (287 52)

R^2 = 99456 DF = 21

SURE Estimates

VP = 97 45CONS + 2 3052GFA + 10 657SNS

(46 897) (03346) (2 7445)

NS = 13 030CONS + 1 0702LNS + 595 54d_3

(115 51) (06257) (273 40)

R^2 = 99471 R^2M = 99471 F = 1972 7 DF FOR F = (4, 42) DF FOR T = 42

7 ALUMINIUM AND OTHER FERROUS/NON-FERROUS METALS

First Stage Equations

$$VP = 3061\ 8CONS + 2640\ 4d_3 - 3387\ 7AC + 2537\ 1d_2 + 8\ 9216LSPF + 3\ 8865LSSS$$

$$(253\ 05) \quad (130\ 31) \quad (333\ 99) \quad (219\ 73) \quad (\ 86096) \quad (1\ 7034)$$

$$-5\ 1456SOMV$$

$$(\ 84875)$$

$R^2 =\ 99392 \quad DF = 17$

$$NS = 90\ 585CONS + 1\ 0381LNS + 3\ 5754SNS$$

$$(104\ 78) \quad (\ 05922) \quad (1\ 8929)$$

$R^2 =\ 98483 \quad DF = 21$

SURE Estimates

$$VP = 3078\ 1CONS + 2602\ 9d_3 - 3383\ 7AC + 2479\ 1d_2 + 9\ 0467LSPF + 3\ 7491LSSS$$

$$(218\ 00) \quad (121\ 55) \quad (309\ 63) \quad (203\ 95) \quad (\ 80201) \quad (1\ 5792)$$

$$-\ 4\ 9238SOMV$$

$$(0\ 7878)$$

$$NS = 99\ 552CONS + 1\ 0327LNS + 3\ 4907SNS$$

$$(109\ 76) \quad (\ 06200) \quad (1\ 9755)$$

$R^2 =\ 96637 \quad R^2M =\ 96621 \quad F = 135\ 84 \quad$ DF FOR F = (8, 38) DF FOR T = 38

8 CHEMICALS AND FERTILIZERS

First Stage Equations

$$VP = 555\ 24CONS + \ 83171GFA + 17\ 262SNS - 21\ 241SWSV$$
$$(120\ 90) \qquad (\ 02043) \qquad (4\ 3215) \qquad (10\ 347)$$
$$R^2 = \ 99277 \quad DF = 20$$

$$NS = 2156\ 9CONS + 7732\ 0d_3$$
$$(435\ 51) \qquad (954\ 16)$$
$$R^2 = \ 87377 \qquad DF = 22$$

SURE Estimates

$$VP = 561\ 57CONS + \ 82863GFA + 16\ 701SNS - 20\ 052SWSV$$
$$(117\ 52) \qquad (\ 01984) \qquad (4\ 1805) \qquad (10\ 010)$$

$$NS = 2164\ 4CONS + 76\ 962\ d_3$$
$$(445\ 07) \qquad (973\ 81)$$

$R^2 = \ 98560 \quad R^2M = \ 98560 \qquad F= 718\ 76$ DF FOR F = (4, 42) DF FOR T = 42

9 MEDICINES AND PHARMACEUTICAL PREPARATIONS

First Stage Equations

VP = 23 244CONS + 98290GFA + 72737LVP

(55 480) (20207) (09734)

R^2 = 99546 DF = 21

NS = -333 29CONS + 4 9339LINV + 16 450SNS

(112 27) (15871) (3 189)

R^2 = 98166 DF = 21

SURE Estimates

VP = 20 115CONS + 85016GFA + 76368LVP

(55 314) (19989) (09633)

NS = -332 43CONS + 4 9222LINV + 17 074SNS

(111 97) (15823) (3 1546)

R^2 = 99200 R^2M = 99199 F = 1300 8 DF FOR F = (4, 42) DF FOR T = 42

10 PAINTS AND VARNISHES

First Stage Equations

VP = 263 66CONS + 6 2175BB + 84517GFA

(139 63) (0 7328) (0 2093)

R^2 = 97784 DF = 21

NS = 3 120CONS + 7 3866SNS

(555 53) (3 3178)

R^2 = 18388 DF = 22

SURE Estimates

VP = 313 76CONS + 6 2573BB + 7 8894GFA

(137 06) (0 7205) (0 2054)

NS = 3126 3CONS + 7 1894SNS

(559 89) (3 3396)

R^2 = 95610 R^2M = 95609 F = 312 11 DF FOR F = (3, 43) DF FOR T = 43

11 CEMENT AND ASBESTOS

First Stage Equations

VP = 543 48CONS + 0 4872GFA + 4232.8d_3 + 1251 9d_2 + 1.5557CF + 496 39d_1

(84 540) (0 0220) (324 84) (141 90) (0 2716) (186 02)

R^2= 0 99806 DF=18

NS = 341 71CONS + 0 94766LNS + 2458 1d_3

(293 45) (0 0807) (761.39)

R^2= 0 96982 DF=21

SURE Estimates

VP = 567 10CONS + 0 49097GFA + 4363 1d_3 + 1242 6d_2 + 1 4005CF + 482 31d_1

(80 054) (0 0206) (302 95) (131 65) (0 25181) (172 43)

NS = 358 15CONS + 0 94162LNS + 2505d_3

(302 15) (0 8301) (783 69)

R^2= 0 99616 R^2M= 0 99616 F= 1446 4 DF FOR F = (7, 39)DF FOR T= 39

12 CLAY AND POTTERIES

First Stage Equations

$$VP = 59\ 468CONS + 3\ 1466BB + 0\ 50184GFA + 4\ 5935SNS + 308\ 87d_3$$

(46 804) (1 1177) (0 15072) (1 0836) (117 33)

R^2= 0 98441 DF=19

$$NS = 591\ 43CONS + 1414\ 1d_2 - 50\ 437SPFV$$

(236 67) (482 66) (16 263)

R^2 = 0 33772 DF=21

SURE Estimates

$$VP = 72\ 392CONS + 3\ 5056LBB + 0\ 44497GFA + 4\ 2471SNS + 268\ 11d_3$$

(44 940) (1 0608) (0 14250) (1 0234) (111 75)

$$NS = 579\ 00CONS + 1448\ 8d_2 -50\ 988SPFV$$

(239 59) (487 75) (16 345)

R^2= 0 96961 R^2 M= 0 96960 F= 212 67 DF FOR F=(6, 40)DF FOR T= 40

13 TYRES AND TUBES

First Stage Equations

$$VP = 339\ 71CONS + 0\ 38707GFA + 3\ 5175CF + 3\ 7057BB + 893\ 67d_2 + 1248\ 6\ d_3$$

(103 60) (0 15241) (1 0533) (0 70246) (223 66) (422 62)

$$- 8\ 7555\ SPFV$$

(3 4400)

$R^2 = 0\ 99794$ DF=17

$$NS = -161\ 94CONS + 1\ 1726LNS$$

(189 36) (0 0304)

$R^2 = 0\ 98540$ DF=22

SURE Estimates

$$Vp = 341\ 26CONS + 0\ 38948GFA + 3\ 4171CF + 3\ 7434BB + 891\ 69\ d_2 + 1207\ 6d_3$$

(93 215) (0 1310) (0 9052) (0 6040) (192 29) (363.31)

$$- 8\ 0058SPFV$$

(2 9571)

$$NS = -147\ 36CONS + 1\ 1695LNS$$

(200 22) (0 03216)

$R^2 = 0\ 99591$ R^2 M= 0 99591 F= 1357 8 DF FOR F = (7, 39) DF FOR T= 39

14 PAPPER AND PAPERBOARD

FIRST STAGE EQUATIONS

First Stage Equations

$$VP = -176\ 89CONS - 2\ 9861LVP + 122\ 41d_3 + 4\ 4080CF + 0\ 5779GFA + 1\ 5208SBB +$$
$$(35\ 234) \quad (1\ 0646) \quad (103\ 08) \quad (0\ 4631) \quad (0\ 0516) \quad (0\ 3744)$$
$$3\ 2572LNS$$
$$(1\ 0656)$$

$R^2 =$ 99877 DF=17

$$NS = -51\ 906CONS + 1\ 1908LNS - 20\ 814SRMV$$
$$(71\ 385) \quad (0\ 0314) \quad (6\ 6651)$$

$R^2 =$ 98688 DF=21

SURE ESTIMATES

$$VP = -164\ 61CONS - 2\ 5712LVP + 111\ 57d_3 + 53547GFA + 3\ 7916CF + 1\ 5200SBB$$
$$(31\ 961) \quad (0\ 9456) \quad (91\ 52) \quad (0\ 0458) \quad (0\ 4132) \quad (0\ 3359)$$
$$+ 2\ 9024LNS$$
$$(0\ 9471)$$

$$NS = -55\ 026CONS + 1\ 1920LNS - 19\ 677SRMV$$
$$(73\ 593) \quad (0\ 0324) \quad (6\ 7453)$$

$R^2 = 0\ 99762$ R^2 M= 0 99762 F= 1191 3 DF FOR F=([illegible], 8) DF FOR T= 38

15 ELECTRICITY GENERATION

First Stage Equations

$$VP = -413\ 56CONS + 12\ 690LCF + 6\ 3654BB - 74\ 947SPFV + 2136\ 6d_2$$

(645 48) (0 6416) (0 9099) (33 877) (1052 1)

$R^2 = 0\ 99032$ DF=19

$$NS = 114\ 08CONS + 0\ 99771LNS + 1672\ 5d_2 + 8611\ 3d_3$$

(761 14) (0 0724) (1379 6) (2935 2)

$R^2 = 0\ 98543$ DF=20

SURE Estimates

$$VP = -268\ 71CONS + 12\ 859LCF - 6\ 0062BB - 63\ 016SPFV + 1893\ 6d_2$$

(630 68) (0 5633) (0 7781) (28 999) (989 07)

$$NS = 186\ 95CONS + 0\ 98124LNS + 1799\ 2d_2 + 9023\ 6d_3$$

(764 19) (0 0655) (1317 8) (2612 1)

$R^2 = 0\ 98298$ $R^2 M = 0\ 98298$ F= 321 87 DF FOR F=(7,39) DF FOR T= 39

TABLE 3 (a) FREQUENCY OF VARIABLES IN THE PRODUCTION EQUATION

VARIABLE	FREQUENCY
GFA	13
AC	2
CF	5
BB	7
SNS	6
SPFV	5
SOMV	3
SWSV	1
SBB	1
LVP	2
LNS	1
LINV	1
LCF	2
LBB	1
LSPF	1
LSSS	1
LSBB	1
d_1	1
d_2	8
d_3	7

TABLE 3(b) FREQUENCY OF VARIABLES IN THE SALES EQUATION

VARIABLE	FREQUENCY
SNS	6
SOMV	1
SPFV	2
SWSV	1
SRMV	1
LBB	1
LNS	10
LINV	2
d_2	4
d_3	6

5 6 A Brief Summary

On the whole there is a significant empirical evidence for the hypothesis of the present study However, other sufficient conditions, like the demand and cost shocks, are also important Any search for a single set of necessary and sufficient conditions will be futile

CHAPTER 6

Summary and Conclusion

6 1 The Problem Recalled

Despite an explosive growth of literature in the field of inventories there are some problems which still remain unresolved One of these is the Blinder Paradox Generally, two aspects of this paradox are highlighted

(a) $V(Y)>V(S)$ at the macro level This is contrary to the usual implication of the production smoothing hypothesis

(b) At the micro level the theoretical framework of production smoothing may appear to be justified Perhaps this is also an empirical regularity as several studies indicate However, $V(Y) > V(S)$ is true at the macro level How can there be a behavioral difference between the two levels of analysis?

The development of the literature that seeks to resolve the Blinder Paradox is along two directions

(a) $V(Y)>V(S)$ at the macro level is entirely a consequence of aggregation procedures and measurement problems The Blinder Paradox is an exaggeration

(b) $V(Y)>V(S)$ even at the micro level As such it is not surprising that it is valid at the macro level as well The fundamental aspect of the Blinder Paradox is therefore the observation that $V(Y)>V(S)$ at both the levels

Studies which take the second position explain $V(Y)>V(S)$ at the micro level by appealing to the firm's reactions to the demand shocks, cost shocks, credit constraints and so on

A perusal of the existing literature highlighted some significant questions

(a) Which of the existing theories has a universal applicability?

(b) How would the demand shocks and cost shocks alter the decision making of the firm in a financially constrained environment?

(c) Will the producer cater to the entire increase in the unanticipated demand in a monopolistic market?

These three questions constituted the focal points of the present analysis

The basic hypothesis of the present study is that two possibilities arise when the firms experience credit constraints (a) Firms in monopolistic competition try to maintain their market share instead of changing the sales levels They do not necessarily make attempts to meet the entire amount of increase in demand For, building a market share and gaining brand loyalty (by catering to the regular customers) is a preferred objective However, this also provides a sufficient condition as was the case with earlier studies

(b) The sales are not influenced by the credit shocks or anticipated changes in the credit conditions Consequently, there is a greater possibility of production volatility to exceed the variations in sales if the firms experience financial constraints in the short run

The present work probes into the effects of the coexistence of demand shocks, the cost shocks and the credit restrictions on the inventory-production decisions of the firms However, this also provides a sufficient condition as was the case with earlier studies

6 2 Highlights of the Empirical Analysis

An Empirical test was conducted for 15 industry groups with a time series data for the years 1964-65 to 1994-95 The data was collected from the Reserve Bank of India The following results may be highlighted

(a) It was found that in 12 out of 15 industry groups *V(Y)>V(S)* Variation in the sales exceeded that in production in the context of Tea Plantations, Paper and Paperboard, and Aluminum and other Ferrous/Non-Ferrous metals

(b) In the present sample it was found that five industries exhibited non-convexity of costs However, contrary to the expectations of the Ramey hypothesis these industries did not adopt the *(S,s)* inventory policy Bulk production was perhaps impractical due to credit constraints [1]

(c) Following the Blinder model framework the empirical study considered the

[1] As pointed out earlier the problem can also arise due to the annual nature of the data utilized in the study

production and sales as the decision/dependent variables

Regression results generally revealed that

(1) Demand and cost shocks affected both the production and sales decisions

(2) Financial variables have no impact on the sales However, they have a significant effect on the production equation By way of contrast, the availability of finance does not cause a change in the sales level These results provide an overwhelming empirical evidence for the basic hypothesis of the present study

6.3 Policy Implications

The following observations are important from the policy perspective

(a) Inventories do not passively react to changes in the business cycle, they lead the cycle Clearly this suggests that output and/or inventory decisions are important to keep the economy stable

(b) When the firms utilize inventories as a leading indicator monetary and credit policies should enable the firms to implement the choices It is possible to dampen the business cycle effect if this happens In short, the sluggishness of policy response may have been the reason for prolonged business cycles

(c) Three sources of change in the output of a firm have been identified in the literature Changes in the demand for its products, cost changes induced by the conditions in the

factor markets, and the demand and supply of credit [2] The real business cycle will be stable except for the short run inflationary conditions If the demand shock is contractionary and the central bank, apprehending the long run effects of a contraction of credit, does not respond with a credit shock in the same direction the effect will be purely short term There may be a temporary deflationary effect at best [3] The optimal credit policy will be to respond with a positive credit shock when the system experiences an expansionary demand shock and remain neutral otherwise

(d) The case of cost shocks is somewhat asymmetric If there are recessionary trends in the factor markets less credit should be made available to the final goods producers and more credit to the factor suppliers

In the final analysis the efficiency of such a credit policy will depend on the ability of the central bank to identify the demand and cost shocks on time, calibrate their intensity and react with an appropriate and measured quantitative change in the credit policy Such a timely monitoring and measured response may be difficult to achieve in practice Limiting the business cycle effects will depend on how well it is done

[2] The monetary policy effects are mainly through the changes in bank credit induced by the reserve requirements As Bernanke and Blinder (1988, 1992) pointed out, the credit channel is perhaps the most important Further, note that the credit policy may operate somewhat selectively on different firms due to the inventory and credit norms imposed by the central bank or the behavior of banks operating under conditions of asymmetric information The credit shocks experienced by specific firms may be either due to the overall credit crunch or due to selective limits imposed on it However, as Blinder (1987, p 327) noted, control of money supply and credit will not give the desired leverage if the non-banking financial intermediaries have a dominant role in the credit markets

[3] Since there will be some excess bank credit under these conditions some observers suggest that it should be channeled in the form of consumer credit so as to augment the demand to stabilize the cycle

6 4 Limitations and Extensions

The approach of this study is subject to certain limitations in concepts, model specification, the database, and the econometric methods The following aspects should be kept in perspective

Firstly, decision models under uncertainty usually assume $Y = S$ They then show that retail price maintenance and fixing output level will be inferior to fixing price alone if the management is risk averse There is no such clear theoretical argument in models which incorporate inventory decisions as well The basic premise of this study is that a similar result is valid even in the general case although fixing both apriori may be optimal under the financial constraint However, a theoretical proof for this proposition is beyond the scope of the present study

Secondly, there is no evidence of any interest rate effect on production and inventory decisions of the firm However, the managers of various companies generally argue that the banking sector charges differential interest rates as the essential mechanism through which credit constraints are operationalized The interest rate variations for a given firm over time may not be as significant as differences across firms at a point of time The average measure of interest rate adopted in this study may be masking the interest rate effect as well A cross section study of firms or a panel data may resolve this issue more definitively

Thirdly, as pointed out by Fair (1989), the use of physical product data produces somewhat different results However, price deflation was not undertaken in the present study For, a comparable price series is not available and deflation may introduce its own bias if any arbitrary series is used Moreover, it appears more realistic to assume that firms in monopolistic competition maintain constant retail price over a fairly long time period Therefore, deflation per se was not expected to alter the results substantially

Fourthly, the econometric techniques have their own limitations Two illustrative points can be cited Consider the results of Chevalier and Scharfstein (1995, 1996), and Rotemberg and Saloner (1986), and Rotemberg and Woodford (1992). They postulate entirely contrary hypotheses about price behavior in different phases of the business cycle However, both studies validated their respective hypotheses using the same econometric techniques Analogously, even with the data utilized in the present study it was found that both the Metzler model and the production smoothing model have done equally well in comparison to the results of Chapter 5 In general, the efficiency of the econometric techniques in distinguishing between competitive hypotheses is in doubt

On the whole, while some refinements in each of these directions is still possible it is unlikely that basic conclusions of this study will be affected in any major way.

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